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Notes on the Quebec Bridge Competition.—II. The Competitive Suspension Design.

(With two-page inset sheet.)

By GUSTAV LINDENTHAL,* M. Am. Soc. C. E.

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The invitation for competitive designs and tenders by the Board of Engineers for the Quebec Bridge, which has been discussed in its bearings on the cantilever designs in Part I. of this article (Eng. News, Nov. 16, 1911), called or professed to call also for plans of the suspension type. The official specifications for the same were, however, so vaguely drawn as to fit apparently only one kind of suspension bridge, namely, one having wire cables on low towers in combination with stiffening trusses. This is at best not an economical form for railroad purposes, and to those who had occasion to study the subject it was a foregone conclusion that a structure of that kind, under the specifications as drawn, would be even more expensive than the costly official cantilever bridge, and that it was not worth trying.

For railroad bridges of long span the suspension type can economically compete with the cantilever, when the stiffening frame is attached directly to the chains and when (as at Quebec) rock shores afford cheap anchorages.

The writer does not want to be considered the champion of the suspension type; he is not the champion of any particular bridge type—no engineer should be—but he believes in competition of merit, the preponderance of which is sometimes with one type and sometimes with another type. He is inclined to believe that for the Quebec Bridge a steel arch construction would have been a close competitor to the cantilever construction and perhaps superior to it. It would have taken less metal, but the question and cost of erection would have required careful study if the initial economy was not to be neutralized. The suspension bridge had the great advantage over both of an unobstructed waterway for its full width.

Reliability and Economy of the Eyebar.

Visitors to the wreck of the collapsed cantilever bridge must have been vividly impressed, as was the writer, with the sight of the tangled mass of several hundred eyebars which had formed the upper chords of the cantilever trusses. They had fallen from a height of over 300 ft. and were twisted in all directions like ribbons. But of the many hundred heavy and long bars, which had been overstressed from shock and tremendous impact in their fall, only one was broken, and that in the neck of the eye, where it had dropped upon a sharp edge. Here was convincing proof of the great superiority of this form of bridge members.

Overstressing and eccentric stresses, which may cause a compression member to buckle, will leave eyebar tension members practically uninjured. Compression members are particularly sensitive to eccentric stress, which is more or less unavoidable and must be taken into account. That cannot be done with hairsplitting accuracy. Eyebars are not so sensitive to eccentric stress; no failures from that cause are known.

The weight of columns is two and more times greater than that of eyebar members for equal axial stress and length. This increases enormously the dead-load of trusses in long spans, as compared with the dead-load of and upon the cables or chains of a suspension bridge.

As the writer had pointed out in past discussions, long before the Quebec Bridge fell, buckling of a compression member in a cantilever truss means its destruction, while the buckling or fracture of a compression member in the stiffening frame of a suspension bridge means merely an inconvenience. In the old Niagara Suspension Bridge, the steel chords of the stiffening trusses had broken and were repaired repeatedly without interrupting traffic. The greater margin of safety, weight for weight of metal, is with the suspension bridge. It is superior to a cantilever bridge for any span in which the dead-load is much greater than the live-load. Temporary overstressing of tension members, up to and even slightly exceeding the elastic limit, will not cause injury, while compression members may buckle long before the elastic limit is reached, as happened in the first Quebec Bridge.

The 1899 Quebec Suspension Design.

When the writer made the competitive design for the Quebec Bridge on the rigid suspension type in 1899 (see Transactions, Am. Soc. C. E., Vol. LV., December, 1905) the only eyebars then obtainable were of carbon steel, which can be safely used in long spans with a unit-stress of 20 to 22,000 lbs. Nickel-steel eyebars, which are 50% stronger and can safely be used with 30 to 33,000 lbs., had not yet been made or tested. Chains of carbon steel would have been exceedingly heavy for a span of 1,800 ft. and appeared impracticable, so the writer proposed chains of pin-connected wire links with unit-stress of 50,000 and having a tensile strength of 160,000 lbs., three times greater (as links) than that of carbon steel eyebars at that time. They were to be of a length and weight easy of erection, and their proper manufacture and prescribed strength and quality had been guaranteed by one of the largest wire firms in Europe (Felten & Guilleaume, of Cologne, Germany). The suspension system which I proposed was that of an inverted spandrel-braced arch with a few modifications; see the upper drawing in Fig. 3, herewith.

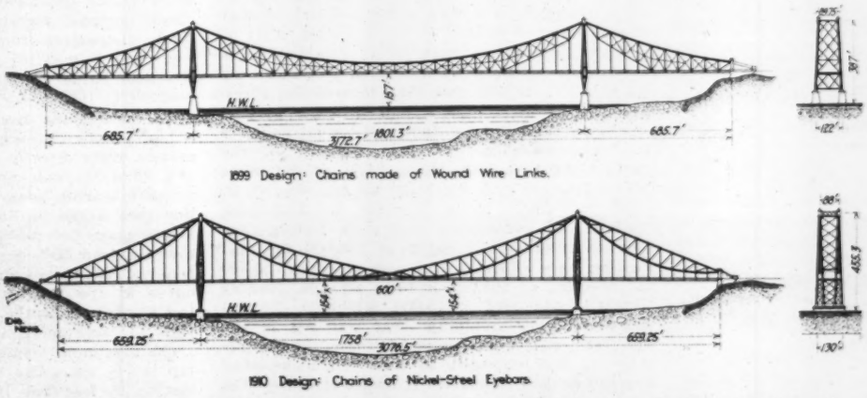

FIG. 3. TWO SUSPENSION DESIGNS FOR THE QUEBEC BRIDGE, 1899 AND 1910.

The suspension plan, however, was not chosen by the Quebec Bridge Co., the supposedly cheaper cantilever bridge being preferred, although the difference in cost was not important. As a fact, the suspension design was the cheaper plan, but that did not fit into the program of promotion at that time.

The cantilever bridge collapsed under its own weight before it was completed. It can be confidently asserted that the wire-link suspension bridge would never have collapsed, and would have safely carried train loads larger than those for which, under the specifications at the time, it was designed.

The 1910 Quebec Suspension Design.

In the meantime the progress in the manufacture of nickel-steel eyebars had made a chain bridge of 1,800 ft. (and if need be of much

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larger span) practicable. The writer selected for this case the system of intersecting catenary chords, as shown by the lower drawing in Fig. 3, or more fully in Fig. 4 (see inset sheet). So far, the system has been used in only two bridges: one, a chain suspension street bridge over the Tiber at Rome; the other, the two side spans of the Tower Bridge (bascule) over the Thames at London. In the last-named the suspension chords are riveted members with three hinges.

The Point Bridge in Pittsburgh over the Monongahela River (a chain suspension bridge of 800 ft. span) is sometimes referred to as belonging to this system, but this is erroneous. In the Point Bridge the chords are not on the lines of intersecting curves. There is (for each truss) but one chain, hanging in its proper catenary curve from the towers; the stiffening frame is on top of the chain; the top chord, of box section, runs in a straight line from top of towers to the middle hinge in the chain; it is without stress from dead-load and subject to tension and compression only from live-load and temperature changes, while in the system of intersecting catenary curves both chords are in tension from dead-load.

The good qualities and economy of the suspension system with intersecting chains for long spans were first recognized in England. Among the various plans for the Forth Bridge were two designs on that system. But as the towers were proposed of masonry, the suspension bridge was more expensive than the cantilever system, which was chosen and built. With high steel towers and deep sag of the chains, the construction can be much cheapened.

In the design for the Quebec Bridge a sag of one-eighth of the middle span was chosen. It required towers 430 ft. high. For a number of reasons it would have been preferable to have only two legs in each tower instead of the four shown in the plan; each leg to rest on a large cylindrical pier, as in the first suspension design. But the size of the stone piers for the metal towers had already been fixed, apparently without regard to anything except the official cantilever design.

As an alternative the old stone piers could have been used. They had not been injured by the collapse of the old superstructure. No settlement of any kind had been observed, which proved that the pier foundations were sound and safe. As the new bridge was to be heavier and wider than the old one, requiring larger bearing area on the foundations, it would have been sufficient for the spreading steel towers of a suspension bridge and also for a cantilever bridge to simply lengthen the old piers at each end and to bind the new foundation and masonry into the existing one, all of which could have been done for less than half the cost of the new piers as planned and now being built. But before it was known what kind of structure the new bridge would be, the new piers had been decided on and were contracted for. Truly a most remarkable proceeding; a million dollars more or less for the piers alone did not seem to matter.

The dimensions of the new piers being in that way given, the towers of the suspension design were accommodated to them so that the column footings should distribute the load uniformly over the entire foundation. Long piers, as mentioned, would have afforded greater width of towers, which would have been better. As it happens, the height of the metal towers of the suspension bridge is 3⅛ times the base (430:130) the same proportion as in the cantilever bridge (290:88).

Form of Chains.

The curve of the chains and the distance between them can be chosen (within certain limits) at will, so that no compression shall occur in them from any portion of the live-load. The chords can then be composed entirely of either eyebars or wire links with simple details.

When this system is intended for a railroad bridge, it is important that the live-load deflections in the middle span shall be a minimum. To that end the motion of the tower tops must be a minimum, which is obtained when the top chain in each end span is laid in a straight line from tower to anchorage. The curve of the bottom chain in the end span is then determined by first locating the equilibrium curve for the entire dead-load (as shown by dotted line in Fig. 4), and then making the bottom chord at each panel-point vertically equidistant from that curve with the top chain.

In the middle span the depth between the top and bottom chords at the quarters was chosen for appearance sake to be nearly the same as the mid-depth in the end spans. The intersecting lines of the chords are thus lopsided curves, vertically equidistant at each respective panel-point from the equilibrium curve for dead-load. As the dead-load is not uniform (it is larger near the towers) the equilibrium curve is not a parabola, nor are the intersecting chords on parabolic lines. Their form is readily determined after a few trial calculations of the dead-load. With that arrangement the web diagonals have no stress from dead-load. *The system is statically determinate.*

Nickel-steel was proposed only for the eyebars, pins and pin plates of the chains and for the long suspenders. All other steel in the bridge was carbon steel, which is about $40 per ton cheaper than nickel-steel.

Unit Stresses in Chains.

In proportioning the sections, the specifications were adhered to, wherever practicable. The live-load was 11,840 lbs. per lin. ft. of bridge. But for the towers, trusses, suspenders and anchorages a live-load of 16,840 lbs. per lin. ft. was assumed, which is equal to E-50 with 50% impact on each track plus 920 lbs. on each roadway. That was done to save work in the computations, since the specifications prescribed that the deflections should be given for that hypothetical live-load of 16,840 lbs. By equating the unit-stresses for the load of 11,840 to those for a load of 16,840, one computation sufficed.

For the tension in the nickel-steel eyebars the unit stress is 27,500 lbs. for a live load of 16,840. It is in this case the equivalent of 25,000 for L. L. 11,840 plus bending under own load.* This stress of 25,000 in nickel-steel eyebars is also the equivalent of 55,000 in wire cables (if used) as prescribed in the specifications, and based there upon a minimum strength of 200,000 lbs. for the wire.

The strength of a wire cable is equal to that of its combined strands or ropes, just as that of a chain is equal to that of its combined eyebars. The strength of a strand, as shown by tests, is 15% to 20% less than that of the wires, because the wires of a strand (whether parallel or twisted as a rope) do not and cannot be made to break unitedly, principally because of the small elongation, only 1½ to 2½%, of the wires before fracture (see Transactions Am. Soc. C. E. 1896, p. 415). Long strands of 200,000-lb. wire will do exceedingly well if on testing they show a minimum strength of 165,000 lbs., including wire splices. The unit stress of 55,000 is one-third of 165,000 in wire strands, just as 25,000 is one-third of 75,000, which is the unnecessarily low minimum that was set in the specifications for nickel-steel eyebars. If strands may be had stronger, so also can nickel-steel eyebars be had stronger. It does not change the relative proportions of strength, so that in the design the 25,000 nickel-steel chain is the equivalent of a 55,000 wire cable for the live-load of 11,840 lbs. and the equivalent of 27,500 in the nickel-steel chain for the live-load of 16,840 lbs.

Since this hypothetical live-load could be brought upon the bridge only [illegible] special preparation, perhaps with iron- [illegible] trains on each track and gravel or pig-ir[illegible]ds on the roadways, and as such a great l[illegible]s free from impact and more in the nature [illegible]+ quiescent dead-load, a high unit-stress co[illegible] employed up to three-quarters of the ela[illegible]limit (minimum 45,000). It follows that [illegible]000 in the chains would have been more ra[illegible]l than 27,500, and even then the chains [illegible]l have been relatively safer than the nickel-st[illegible] compression members in the cantilever design.

The suspension design is not such [illegible] the writer would have made if free to follow [illegible]s own judgment. It was drawn to suit the [illegible]nitations of the piers and the prodigal specifi[illegible]ions, though they evidently did not contemplat[illegible] a chain design.

As it is, the nickel-steel chains are strong enough to carry the dead and live-loads of four railroad tracks, two wagon roads and trolley lines, including 4,000 lbs. more steel in the floor for the two additional railroad tracks. The live-load for such case would be very ample, 20,000 lbs. per lin. ft. The unit-stresses in the same chains from all that load would then be only 30,000 instead of 25,000.

In my judgment the design is as wasteful in the chain-trusses and as badly balanced as is the Board's design, but it was fitted to the rules as found.

The design of the chains included consideration of the secondary stresses from frame distortion. These were found to be negligible except at the towers, where an addition of 5% to the eyebar sections and pin-plates was found to be sufficient for the purpose. The angular deflections are larger near the towers than at other points of the trusses.

Towers and Anchorages.

The towers, of carbon steel, have narrow flat bearings at bottom and pin bearings at top. See Figs. 7 [inset], 9 and 10. The maximum compression (from dead and hypothetical live-load, wind and traction stress) is 16,000 at middle, increasing towards top and bottom to 20,000 lbs., corresponding to 14,000 and 18,000 respectively for the live-load of 11,840 lbs. All the columns are closed compact sections. The stresses are definitely distributed from the single pin bearing at top. The framed tower as a whole is far within the safe value by Euler's theory properly applicable to this case.

The entire load from trusses and floor is delivered by the chains at top; no part of the floor system rests directly on the towers. The floor can slide through the towers and can deflect without bearing upon the towers below the floor line (see detail in Fig. 12). This arrangement brings upon the two suspenders nearest to each tower a load 50% greater than upon other suspenders, but it avoids a peak in the deflection curve at the towers which would result from the elongation of the suspenders in conjunction with the shortening of the towers under load.

The maximum longitudinal motion of the tower top is 7½ ins. The bending stresses from that motion are less than 1½% of the vertical stresses.

At the base the horizontal component is taken up by steel beams embedded in the masonry, which protects them against temperature stresses.

The details and shopwork of the towers are within the capacity of existing plant, as in fact is the entire design of the bridge, so that no new plant should be needed for its fabrication. This is in contradistinction to all the cantilever designs, which require new large plant and shops, estimated to cost more than one-million dollars.

The erection of the towers is no more difficult than that of structural steel for many high buildings, which has become an everyday operation.

The anchor chains run in straight lines from the anchor piers of granite into anchor pits excavated in the rock; they are encased in concrete as shown in Fig. 8 [inset].

There is a large excess of section in the plain bars of carbon steel between pin holes. I preferred plain bars for the anchor chains to forged eyebars, notwithstanding their greater weight and cost, because their elastic

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*Special attention was given to the bending stresses in the eyebars of the chains (there were 5,120 bars in the chains subject to bending) from their own weight, which stresses are not as high as they are usually assumed to be. The extreme-fiber stress C was determined from the formula

$$C = \frac{d}{1 + \frac{5}{4}\,\frac{s}{E}\,\frac{l^2}{h^2}}$$

obtained by equating the bending moment from the weight of the bar to the opposing bending moment caused by axial tension upon the bent bar. In the formula

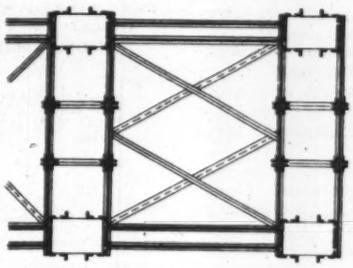
d = max. bending stress in a rectangular bar when free from longitudinal tension,
s = unit-stress for axial tension,
E = modulus of elasticity,
l = length of bar,
h = depth of bar,

The actual deflection is

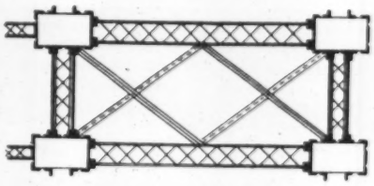
$$f = \frac{5}{24}\,\frac{C}{E}\,\frac{l^2}{h}$$

elongation under load is smaller, and the motion of the tower top is thus minimized. The lower ends of the anchor chains take hold of anchor girders, bearing with a grillage of 10-in. eyebeams against granite masonry, and against the concrete in the anchor pits.

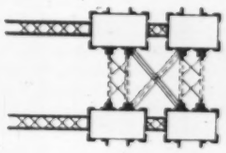
As regards the resistance of the anchorage to lifting and sliding, the depth of the anchor pits and the length of anchor chains were chosen on the assumption that they are in loose rock. If rock should be fairly compact, a substantial reduction in cost of anchorages could be made. But even with that assumption the total cost of anchor masonry was less than the similar cost for a cantilever bridge. The quantities for one anchorage are stated in tabular form on p. 616. The anchorage stresses are stated under Fig. 8 [inset].



Section E-F.



Section G-H.



Section C-D.

Truss Details; Traction Forces and Expansion Joints.

The form of the trusses as already noted is such that the diagonals are not affected by the dead-load but only by live-loads. The dead-load decreases from the towers towards the middle and towards the anchorages respectively, so that the equilibrium curve is not a quadratic parabola.

The eyebars, pins, and pin-plates are of nickel-steel, also the long suspenders. All other parts are of carbon steel. Web members are subject to alternate tension and compression, and are field-riveted to the gusset-plates (see Fig. 6) [inset]. The pin-plates have very low bearing stresses on the pins.

The eyebar heads have 50% excess of section over the body of the bars. The pins are of di-

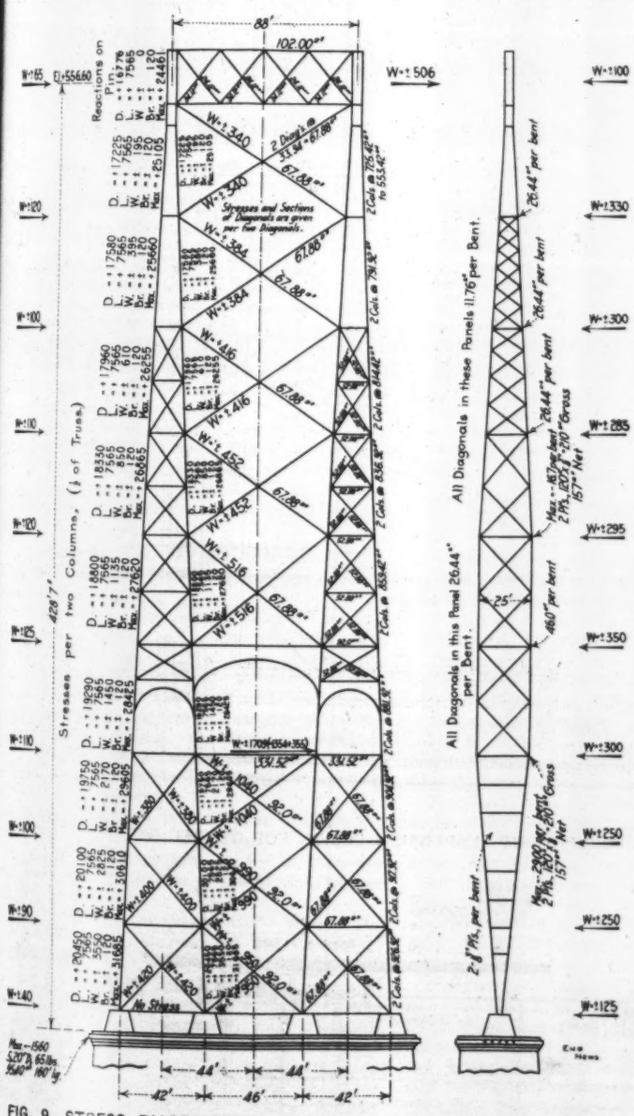

Stresses per two Columns, (½ of Truss)
All Diagonals in this Panel 26.44" per Bent.
All Diagonals in these Panels 11.76" per Bent.
No Stress
44'
46'
42'

FIG. 9. STRESS DIAGRAM OF TOWER; 1910 SUSPENSION DESIGN FOR QUEBEC BRIDGE.

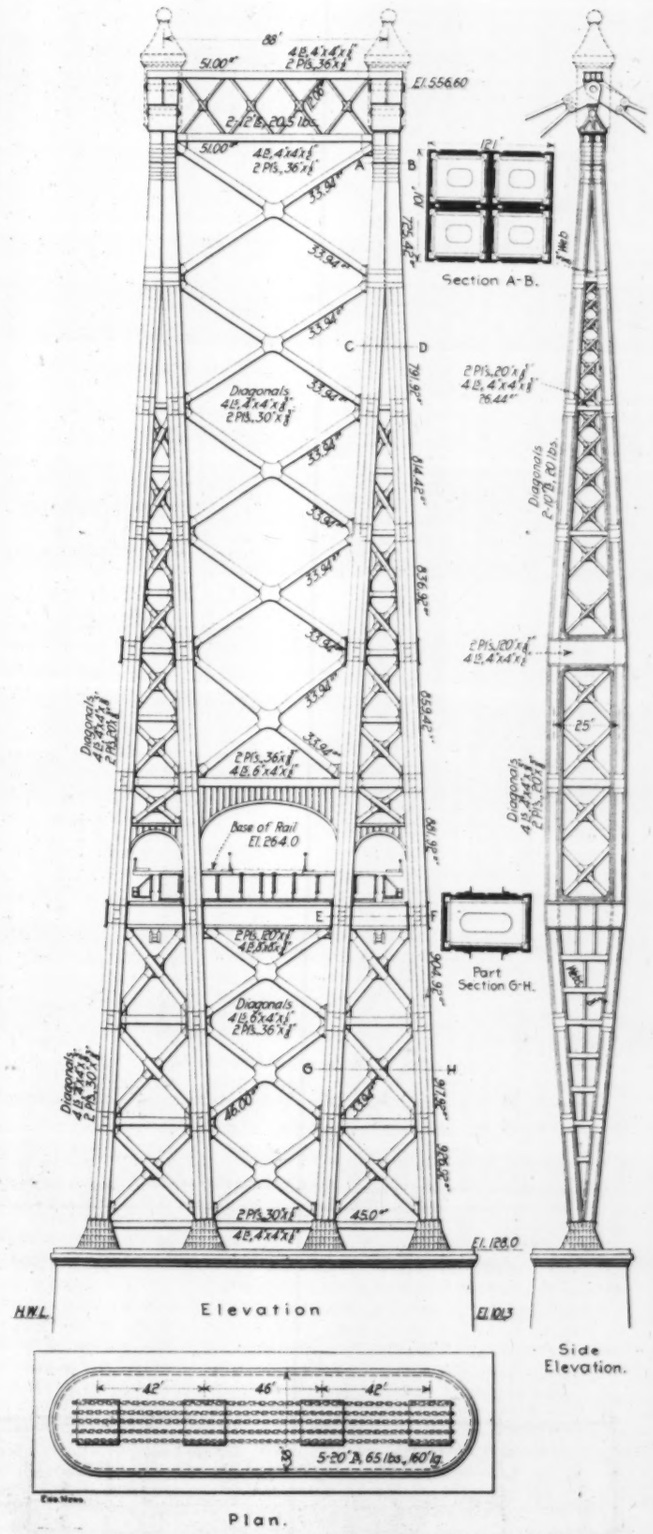


FIG. 10. GENERAL DRAWINGS OF TOWER; 1910 SUSPENSION DESIGN FOR QUEBEC BRIDGE.

ameter equal to the width of bar, so that the bearing stress behind the pin shall not exceed the tensile stress in the bar. The pins have holes drilled through the center for their entire length, to ascertain the soundness of the material in their interior.

The stresses in the web members alternate between 10,000 compression and 14,000 tension for the hypothetical live-load (16,840) exclusive of bending stresses in diagonals from own load, for which special additions were made in the flanges. For the live-load of 11,840 lbs. corresponding stresses are 7,000 and 10,000. The unit-stresses were kept low because reversional stresses occur under each passing load.

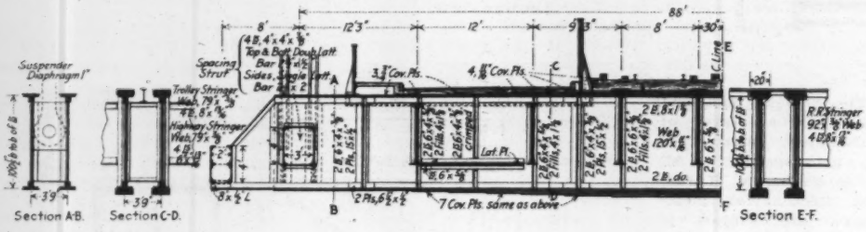
All web members are of a weight and length to be completed in one piece at the shops. The largest is about 100 ft. long, and weighs about 20 tons.

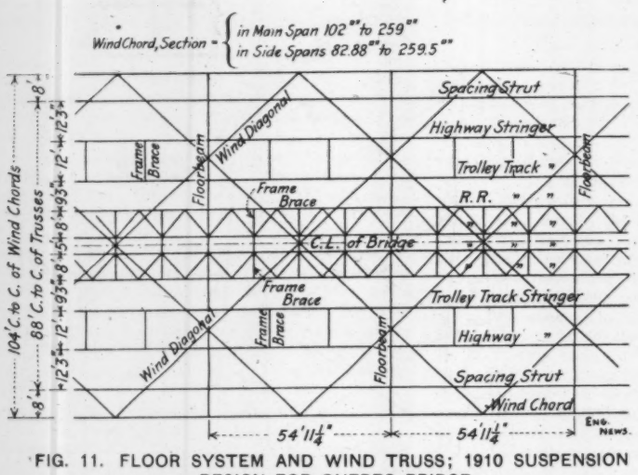
The traction forces are assumed to be absorbed by the floor system, connected through the wind diagonals, and are delivered through special tension members at midspan into the chains, whence they pass through the trusses and over the towers to the anchorages. In

QUANTITIES OF EXCAVATION [illegible] MASONRY (BASED ON PROFILE AS [illegible] OWN ON DRAWING OF ANCHO[illegible]GE).
North Shore.

Excavation:			
2 Anchorage pits	= 2 × 10,5[illegible]	21,040	cu. yds.
2 Side walls	= 2 × 5,1[illegible]	10,220	"
Front wall	= [illegible]	280	"
2 Piers	= 2 × [illegible]	860	"
Total		32,400	cu. yds.
Masonry:		Concrete. cu. yds.	Granite. cu. yds.
2 Anchorage blocks	= 2 × 8,[illegible]	1,800	660
2 Side walls	= 2 × 7,6[illegible] / 2 × 420	15,390	840
Front wall		2,730	310
2 Piers	= 2 × 1,4[illegible] / 2 × 610	2,340	1,220
2 Concrete housings	= 2 × 1,040	2,080	...
		24,940	3,030

Note:—This concrete includes [illegible] cu. yds. for weight only (1:5:10).





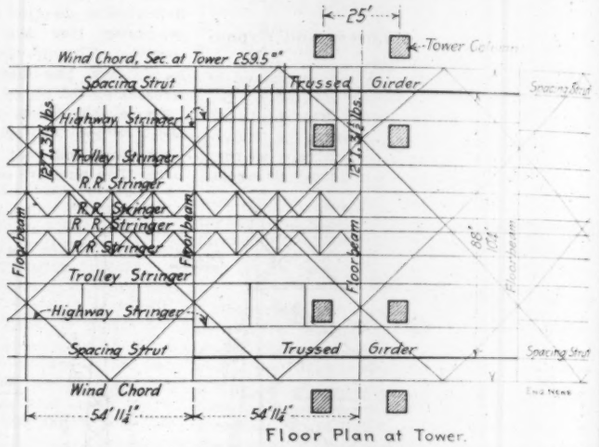


FIG. 11. FLOOR SYSTEM AND WIND TRUSS; 1910 SUSPENSION DESIGN FOR QUEBEC BRIDGE.

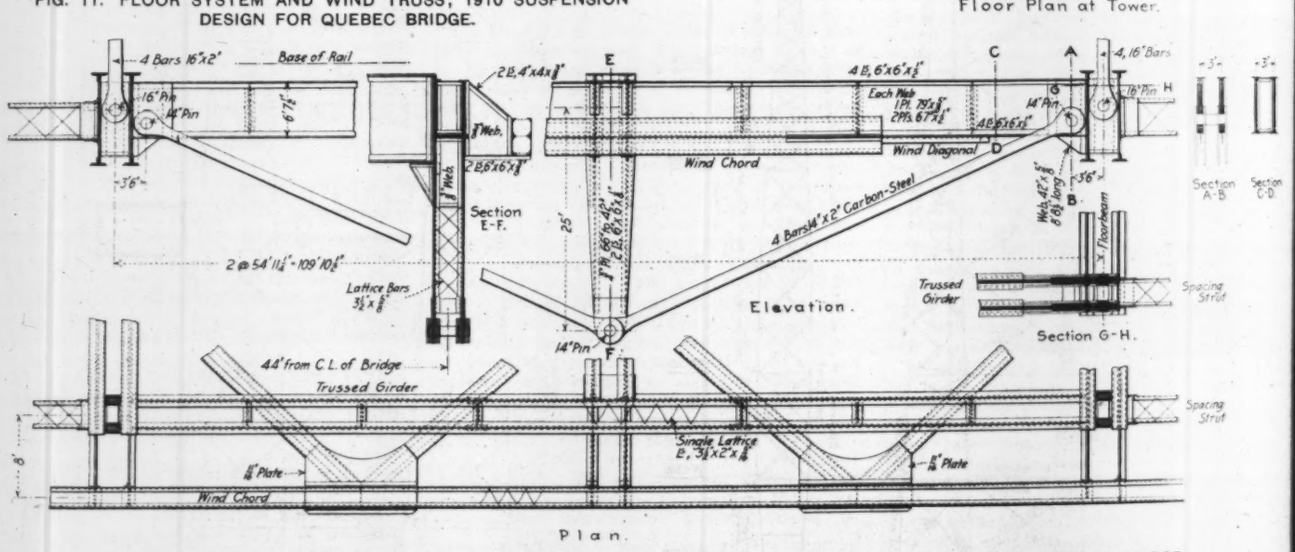


FIG. 12. TRUSSED-GIRDER SUPPORT OF FLOORBEAM AT TOWER; 1910 SUSPENSION DESIGN FOR QUEBEC BRIDGE.

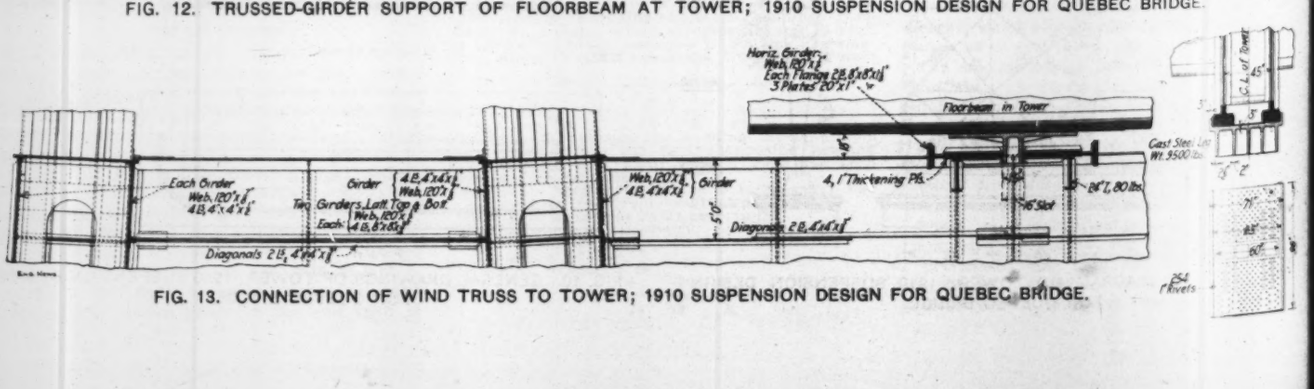


FIG. 13. CONNECTION OF WIND TRUSS TO TOWER; 1910 SUSPENSION DESIGN FOR QUEBEC BRIDGE.

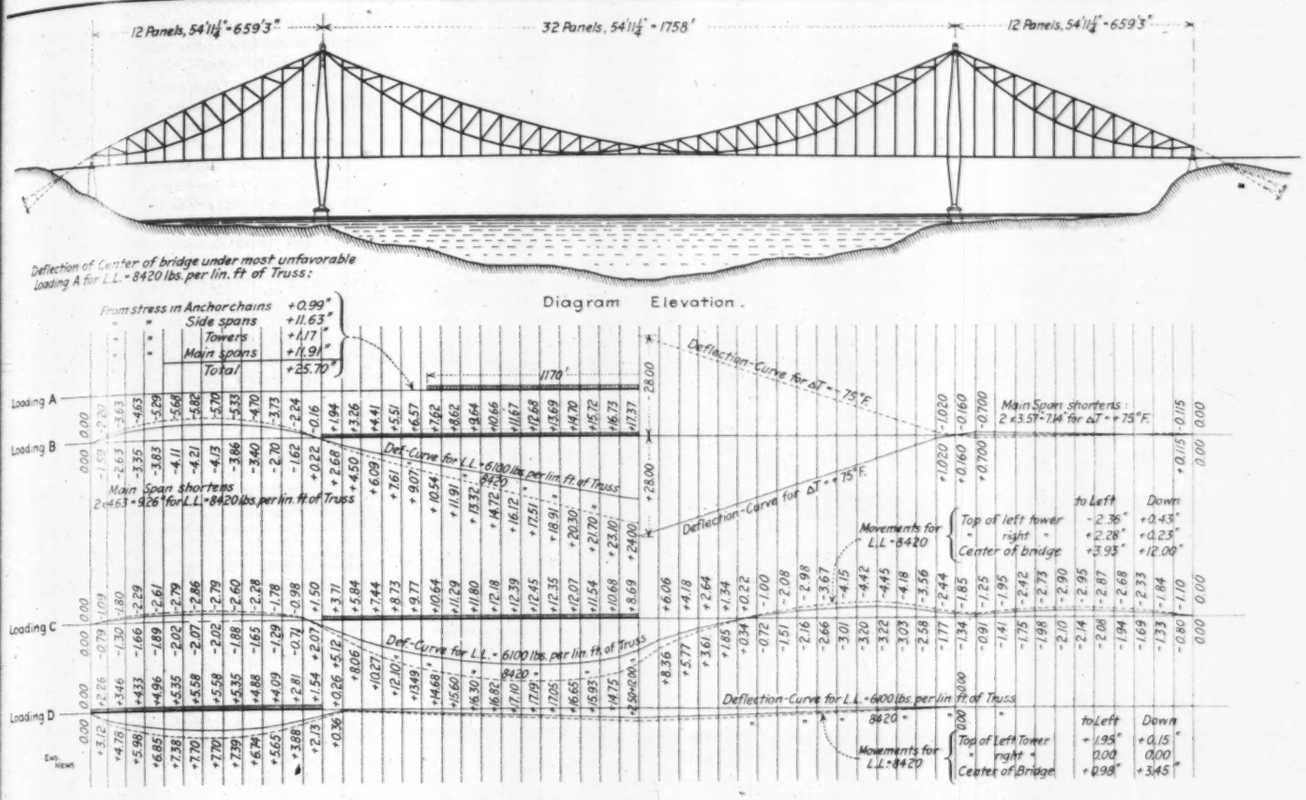

12 Panels, 54'11¼" = 659'3"
32 Panels, 54'11¼" = 1758'
12 Panels, 54'11¼" = 659'3"
Deflection of Center of bridge under most unfavorable Loading A for L.L. = 8420 lbs. per lin. ft. of Truss:
Diagram Elevation.
From stress in Anchor chains +0.99"
Side spans +11.63"
Towers +1.17"
Main spans +11.91"
Total +25.70"
1170'
Deflection-Curve for ΔT = 75° F.
Main Span shortens: 2 × 3.57 = 7.14" for ΔT = + 75° F.
Loading A
Loading B
Loading C
Loading D
Def. Curve for L.L. = 6100 lbs. per lin. ft. of Truss
Main Span shortens 2 × 4.63 = 9.26" for L.L. = 8420 lbs. per lin. ft. of Truss
Movements for L.L. = 8420
Top of left tower to Left -2.36" Down +0.43"
" right " +2.28" +0.23"
Center of bridge +3.93" +12.00"
Movements for L.L. = 8420
Top of Left Tower to Left +1.95" Down +0.15"
" right " 0.00 0.00
Center of Bridge +0.98" +3.45"

FIG. 14. DEFLECTION CURVES FOR QUEBEC RIGID SUSPENSION BRIDGE DESIGN (1910).

reality these special members are superfluous, because they can act only after the great inertia and resistance of the continuous and heavy floor and of the suspenders to motion over the full length of the bridge are overcome—an improbable event.

There are on this bridge no open or expansion joints as on a cantilever bridge. Such joints being the cause of shock and blows upon the track, they are placed upon rigid supports at each abutment, where special provision for expansion can be made, with overlapping rail joints sliding on cast-steel supports.

The expansion of stringer bearings on each abutment is ± 7.6 ins. max. The slow pendulum motion in the short suspenders near the anchorages from temperature changes is allowed for by using here flexible suspenders made of wire links or wire ropes.

Floor System and Wind Truss.

The drawing Fig. 11 shows the floor system and the wind truss.

The stringers are throughout built in between the box floorbeams. All eight stringers have their bottom flanges in the same plane. The wind diagonals are riveted to their bottom flanges at all intersections.

The wind chords are carried on the bracketed ends of the floorbeams. The wind truss is entirely independent of the vertical trusses, and its web arrangement is such that floorbeams are not utilized as struts.

In order to pass the floor system through the towers, the floorbeam in the tower is carried at each end by trussed girders, which in turn are supported by suspenders nearest to towers (Fig. 12).

The wind truss is purposely made wider than the width between trusses (88 ft.) to obtain great lateral rigidity. It is 104 ft. wide between wind chords (1/17 of the river span). The reaction of the wind truss is delivered to the towers through a sliding bearing of cast steel (Fig. 13), going first into a horizontal plate-girder and thence into the plate-girders which tie and brace the columns of the towers at this point. This bearing permits the floor to deflect without taking load.

The wind girder is continuous through the towers and has its largest chord sections here. It has an average weight of 2,000 lbs. per lin. ft., including wind diagonals, which is low, resulting from the great distance between chords and from the continuity of the trusses.

No wind bracing is required between chains and suspenders, both being in stable equilibrium and resisting wind pressure by their inertia. The chains deliver their share of lateral pressures at top of towers and at center of middle span, and the suspenders deliver their share of wind pressure directly into the wind truss. The total weight of metal required for wind bracing in the towers alone equals the total weight of the wind truss 3,080 ft. long.

Deflections.

The deflections of a heavy suspension bridge under live-load are sluggish and free from vibrations, in which respect they differ advantageously from the jerky vibrations of the cantilever system. The deflection diagrams in Fig. 14 show the extreme deformations under the hypothetical live-load of 16,840 lbs., which could not be realized, and under temperature changes.

The maximum deflection from a temperature change of 75° F. would be ± 27.7 ins., causing a change of grade of 0.27%.

The maximum deflection from live-load in the most favorable position would be 25.7 ins. at center, causing an average change of grade of 0.27%.

The maximum deflection in each half from most unfavorable position of live-load would be 17.2 ins., causing a change of grade of 0.45% at tower and 0.55% at middle of bridge.

All these deflections from temperature and the hypothetical live-load do not produce a grade steeper than 1% at any point of bridge, or less than the grade of 1% on the approaches to the bridge.

The greatest change of grade would occur from live-load and high temperature acting together. In all these deflections the great resistance of the suspended structure to change of form by reason of its own great weight and inertia and its stiff floor is not considered. These reduce greatly deflection and vibration (see Transactions Am. Soc. C. E., Vol. LV., December, 1905, p. 62).

All the above deflections from live-load are therefore purely academical and of no practical importance. They could not be produced except by special preparations requiring several days and by stopping all regular traffic over bridge. In ordinary operation a heavy coal train of 40 cars weighing 4,500 lbs. per lin. ft. would produce a deflection of less than 6 ins., or 1/3,600 of the span, which is a smaller ratio than in truss bridges of ordinary span, where 1/1,200 is considered sufficiently rigid.

A heavy passenger train with two locomotives moving at the rate of 60 miles per hour would deflect the 1,800-ft. span 2 ins. at the center (1/10,000 of the span) and require for it 16 sec. It is clear that the suspension bridge, if properly designed, leaves nothing to be desired in rigidity. The deflections are as much under the control of the designer as in any other bridge type. The objections to a suspension bridge for railroad use because of deflections are based either on ignorance or on prejudice.

Erection.

The erection of the chain bridge is as follows: Falsework of steel in each end span carries the floor and also about one-half of the load of the trusses (see Fig. 15). The eyebars outside of web members are at first left off so that the top of the towers can be connected with the anchorages before the erection of the middle span commences. For the erection of the middle span temporary cables are used composed of wire ropes, temporarily anchored to each anchorage.

The first set of eyebars for the middle span is supported from the temporary wire cables. The erection commences at the towers and progresses towards the center, leaving the pins sticking out on each side. After the first set of eyebars of the upper and lower chains are connected at the center, the chains become self-supporting. The vertical and diagonal web members are so designed that they can be slipped in at any time after the pin plates in the top and bottom chains are in place. As the eyebars without stress are shorter than the eyebars under stress in the chains, they are pushed on with the aid of pilot nuts and screw rods, passing through the holes in the pins, an operation familiar to workmen erecting large pin-connected bridges.

After the trusses are erected, the floor system

and wind truss are put in place. All riveting of web members and in floor system is done when all the steel has been erected, and when the chains have their full strain from the dead-load.

Comparison of Suspension Design and Cantilever Design.

Both designs being based upon the same live-loads and specifications, and having the same length of span (with only small differences in the end spans) comparison of the respective steel weights is permissible.

The unit-stresses in the floor system, suspenders and wind trusses are exactly alike. But the factor of safety in the suspension trusses is the larger, since the tensile unit-stress of 25,000 in the nickel-steel chain has obviously a larger margin of safety than the compressional unit-stress of 19,000 for the same loads in the cantilever design. If, for instance, such a load were applied in both designs as to increase the stresses 100%, that is to 50,000 in the chains of the suspension bridge and to 38,000 in the compression members of the cantilever bridge, the eyebars of the chains would still be doing duty, although strained up to or a little beyond the elastic limit (at most getting a set, but not fracturing), while the long compression members of the Board's Design would most probably have passed the buckling limit, causing collapse as they did in the old bridge. The limits of safety in any metal bridge are set by the compression members if designed under any existing specifications. This fact makes a properly designed suspension bridge the safest of all metal bridges.

As already stated the live-load assumed at 11,840 lbs. per lin. ft. of bridge for the Board's Design is much larger than any that can be ordinarily brought upon the bridge. A load of 10,000 lbs. per lin. ft. in the trusses or on the chains would be ample to cover the heaviest coal trains on both tracks and any wagon or trolley-car loads that may happen upon the bridge simultaneously. In a very long span the live-load on a wagon road is of small importance compared with the weight of heavy railroad trains and of the structure itself. It would be sufficient to provide a floor construction for the wagon roads strong enough for the usual concentrations, without special addition to the trusses. The specifications, however, call for an addition in the trusses of 1,840 lbs. wagon and trolley load. It is equivalent to four lines of heavy touring cars, and would take 600 of them to cover the 1,800-ft. span, or 1,000 to cover the entire length of the bridge. It is also equivalent to 22,000 persons on the 1,800-ft. span, or 36,000 (about half the population of the city of Quebec) on the entire bridge. The specified amount of 1,840 lbs. per lin. ft. for the two roadways on the bridge is a larger live-load than the four cables of the Brooklyn Bridge (which has the heaviest street traffic of any long-span bridge in existence) carry from the densest street-car, wagon and pedestrian traffic during rush hours.

As there is simultaneously assumed a snow load of 1,500 lbs. per lin. ft., which means snow more than 12 ins. deep on the roadways, it seems hardly possible that a dense street and trolley traffic could be trudging through the slush over the bridge at the same time, and with two heavy overloaded coal trains speeding both in the same direction. But on such live-loads with low unit-stresses the designs are based, with the following results:

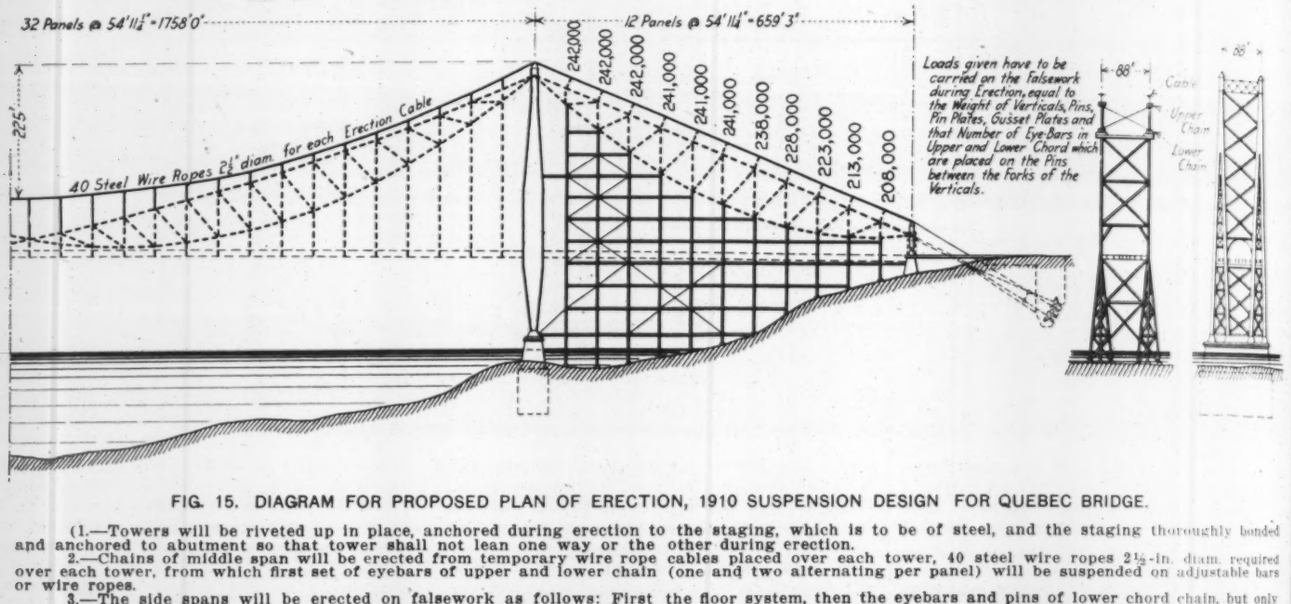

32 Panels @ 54'11¼"=1758'0"
12 Panels @ 54'11¼"=659'3"
225'
40 Steel Wire Ropes 2½" diam. for each Erection Cable
242,000
242,000
242,000
241,000
241,000
241,000
238,000
228,000
223,000
213,000
208,000
Loads given have to be carried on the Falsework during Erection, equal to the Weight of Verticals, Pins, Pin Plates, Gusset Plates and that Number of Eye-Bars in Upper and Lower Chord which are placed on the Pins between the Forks of the Verticals.
88'
Cable
Upper Chain
Lower Chain

FIG. 15. DIAGRAM FOR PROPOSED PLAN OF ERECTION, 1910 SUSPENSION DESIGN FOR QUEBEC BRIDGE.

(1.—Towers will be riveted up in place, anchored during erection to the staging, which is to be of steel, and the staging thoroughly bonded and anchored to abutment so that tower shall not lean one way or the other during erection.

2.—Chains of middle span will be erected from temporary wire rope cables placed over each tower, 40 steel wire ropes 2½-in. diam. required over each tower, from which first set of eyebars of upper and lower chain (one and two alternating per panel) will be suspended on adjustable bars or wire ropes.

3.—The side spans will be erected on falsework as follows: First the floor system, then the eyebars and pins of lower chord chain, but only that number of eyebars that comes between the forks or the pin plates of the verticals. Then the gusset and pin plates, then the verticals and then those eyebars of upper chain located between upper forks of verticals leaving the pins projecting on each side. The remaining eyebars will be pushed on after the chains of the middle span are partially erected and the chains self-supporting from anchorage to anchorage.

4.—After first set of eyebars for each chain in the middle span is connected up and self-supporting, the remaining eyebars, pin plates and gusset plates (for suspenders and web members) will be pushed on to the pins until chains are completed. Then follows the erection of the verticals, the diagonals, which are without strain from dead load and can be put in place after chains are completed. Thereafter the suspenders and floor system of the middle span to be erected.)

BOARD'S DESIGN.

The steel weights are:

	Carbon Steel.	Nickel-steel.
Two side spans	18,219,000	46,273,000
Main span	21,169,000	58,293,000
Anchorages	3,416,000	193,000
	42,804,000	104,759,000
Total weight	147,563,000 lbs.	
Length of spans	586 1,758 586	
Total	2,934 ft. (?)	

The cantilever contained therefore, per lin. ft.:

35,700 Nickel
14,600 Carbon

Total 50,300 lbs

Small girder approaches, together about 200 ft. long and containing 1,400,000 lbs. carbon steel, bring u pthe total weight to 148,963,000 lbs.

SUSPENSION DESIGN.

The steel weights are:

	Carbon Steel.	Nickel-steel.
Two side spans	16,715,000	23,843,000
Main span	23,167,000	31,660,000
Towers	31,325,000	75,000
Anchorages	17,745,000	855,000
	88,952,000	56,433,000
Total weight	145,385,000 lbs.	
Length of spans	660, 1,758 660	
Total	3,078 ft.	

The suspension bridge contains therefore, per lin. ft.:

18,300 Nickel
29,000 Carbon

Total 47,300 lbs.

It will be observed that more than one-third of the total steel (50,050,000 lbs.) is in the towers and anchorages. This weight does not come upon the suspension trusses, which explains the small proportion of nickel-steel as compared with the cantilever trusses, which have to carry nearly the entire weight of the steel.

The above figures, based upon minutely elaborated designs, show that while the total weights of steel are nearly the same in [illegible] designs, the suspension design has only [illegible] one-half of the costly nickel-steel.

The suspension design was [illegible] no one part stinted, as may be seen from [illegible] plans. The steel in the floor system, consis[illegible] of box floor-beams, stringers and beams, [illegible]hs 8,800 lbs. per lin. ft. in the suspension [illegible]ge against 7,- 000 in the Board's Design.

The difference of 1,800 lbs. s[illegible] resulted from a liberal interpretation of the [illegible]ecifications as regards the details, the use [illegible]pacing struts between floorbeams to facilita[illegible] erection, etc. Moreover, the stringers are built in between the floorbeams throughout, giving a stiffer floor, while in the floor of the cantilever bridge the stringers rest (except in the suspended trusses) on top of the floorbeams, which saves much weight in details of connections. The sections and connection of girders in the Board's design are close to the specifications without margins, and for the wind struts thin angle sections are used, which would not pass muster under most of the specifications for American railroad bridges. The least thickness of two-faced steel in the floor and bracing below the floor should have been ½-in., to provide margin for the insidious corrosion of iron over saline waters. Metal for that protection should not be grudged. But in the official design the thickness of two-faced metal was in some places less than ⅜-in., as in the webs of the rolled I-beams under the roadways.

The quite proper desire to save metal was evident from these details in official plans, but the mistaken economy by the pound in floor details appears like a parody, when compared with the waste of thousands of tons in the trusses through wrong design. Another cause of wastefulness was the unnecessarily heavy track construction, and the concrete foundations for the roadway and sidewalks, amounting to 6,500 lbs. per lin. ft., just where great weight could have been saved.

This heavy track and flooring, unsuited for very long spans, was imposed upon all competitive plans. It is also in the suspension bridge. By leaving off the heavy concrete roadways and sidewalks and reducing the live-load to 10,000 lbs., one of the bidders reduced the steel for the cantilever bridge and approaches to 98,000,000 lbs. The latter is the accepted plan, as before mentioned, but for all that it cannot be considered a good plan, because with the same steel and at the same cost a cantilever bridge of better design could be had, as already

mentioned, which would have accommodated also the roadways and trolley lines, as had been intended from the beginning.

The suspension bridge could, of course, in like manner be reduced in weight of steel to 98,000,000 lbs., of which 61,000,000 would be carbon and 37,000,000 nickel-steel. Tenders invited on such design in the manner of the leading American railway companies would have shown the cost of the steelwork most probably under $7,000,000. Adding to it a liberal allowance for land, piers and anchorages, interest during construction, contingencies and engineering, the total cost for a very strong railroad, wagon and trolley line bridge would have been about $10,000,000 and the time of completion four years, counting from date of order.

The Quebec Bridge when completed within the next four years will have cost the Canadian Government about $18,000,000, including the loss of the old bridge, cost of engineering and interest during construction. And then it will have only an unsightly two-track railroad bridge without wagon roads and trolley lines. The latter accommodations would have been of great local benefit, and they may later on require a separate bridge, which if ever so cheap and light (as a half stiffened wire-rope suspension bridge for slow loads) will cost $3,000,000 more. Together $21,000,000 for an accommodation that could have with certainty been obtained for $10,000,000.

The Quebec Bridge is one of those instances of large work which illustrates the costliness of drifting along with poor engineering preparation and mismanagement. If the subject had been studied, worked out and reported upon, as any large work of this kind should be, it would have meant the saving of many million of dollars, many human lives and a handsome bridge fully completed by this time.

The Contractor's View of City Contracts and Specifications.*

By C. A. CRANE.†

The subject of this paper is one which has been often and thoroughly discussed for the last several years. A most admirable paper was presented before your society by Mr. John C. Wait some six years ago. The matter was also very exhaustively discussed before the American Society of Civil Engineers in a paper presented by Mr. William B. Bamford, in 1910, and "The Contractors' Point of View on Engineers' Contracts and Specifications" was the subject of a paper before the Association of Engineering Societies, presented in July, 1907, by Mr. James W. Rollins, Jr., president of the contracting firm of Holbrook, Cabot & Rollins.

However, in spite of the discussion brought out by those papers, and the almost unanimous agreement that contracts were too one-sided, no perceptible change for the better has occurred.

Every one of you engineers here tonight will agree with me that there are many unfair clauses in contracts you have been engaged upon, but individually, you may say, "I didn't prepare it—I had nothing to do with the specifications—why don't you make the kick to the man who drew it up?" And when we find the man who drew it up, he says, "These contract matters are up to the Corporation Counsel," or "They are regulated by charter or ordinance," and as to the specifications, unless they be for some extra large undertaking, the old ones are copied year after year because there has been no general demand to change them.

We are all agreed on one thing—none of us will ever live to see a perfect contract on city or any other public work. So long as the bidding on contracts is unrestricted, the contract must of necessity be drawn to protect the city, or the state or the government, from dishonest practices. No reputable contractor can object to this condition nor will he deny its necessity, but what he does object to is, that those clauses which are inserted in the contract more for protection than literal enforcement, are often applied to him regardless of good and substantial performance, in order to secure strict compliance with the specifications. I allude to the so-called "Club Clauses."

Mr. Rollins, in his paper just alluded to, says: "Every unnecessary or unfair clause in a specification has its part in limiting competition and in lowering the standard of honesty among contractors. A clause that may be used as a club can be avoided in one of two ways, either by not bidding on work governed by the clause or by using graft to insure that it shall be a dead letter."

An instance of one of these impossible requirements, or club clauses, is to be found in the contract for asphalt pavement in the provision for tests just prior to the expiration of the guarantee. The clause provides that if any portion of the pavement shall show a variation of more than ⅜ in. under a 4-ft. straight edge, such portion shall be immediately repaved by the contractor.

Is there a pavement in the country, let alone Greater New York, which can comply with so rigid a test after five years' usage? I very much doubt it, and at the same time I have never heard of any engineer who applies his 4-ft. rule to the entire surface of the street before issuing his certificate. Perhaps this clause was responsible for the report of an engineer in the Bureau of Highways not long ago who refused to certify that the work had been placed in acceptable condition because the pavement still showed waves of sufficient magnitude to make water hesitate! In making the statement that this impossible test is not resorted to, it should not be presumed that it has been avoided by payment of graft, as might be assumed from the foregoing quotation. It is simply because the requirement is so thoroughly ridiculous that it is hard to conceive of any engineer who would have the nerve to proceed toward its enforcement, or of any Borough President, or court which would sustain him if he should.

The contracts prepared by the Board of Water Supply for the Catskill Aqueduct are conceded by contractors to be as fair as any they have ever worked under. The specifications are explicit in defining every detail that enters into the construction, and just what the payment for each item includes. No expense has been spared in procuring the best engineering skill, and the advance information to bidders is presented in a most complete manner. Yet the clause disavowing responsibility for the estimate appears in the contract.

The contractor is told he must conduct his own investigations in the six weeks, at most, before submitting his bid, which of course he cannot do. He is bound to be guided by the information furnished by the engineers, and if it subsequently turns out to have been misleading, to a degree, entailing additional work and expense, such a contingency should be provided for in the contract.

Engineers who have spent months in taking borings, making subsurface examinations and preparing their estimates know how impossible it is for the contractor to verify this work before bidding, and they should be the first to endeavor to have this clause eliminated in order to allay a sometime suspicion that the low bidder obtained advance information which was withheld from his competitors, and that he got the job because of such exclusive information.

This clause was decided in the contractor's favor not long ago by the Connecticut courts. The portion of the opinion relating to the legal status of the estimated quantities was very clear. It stated that the representations in the advertisement and the notice as to quantities carried with them "the assertion of being made upon some basis of superior knowledge. Their purpose was to supply information to persons who were expected to act upon it in a business dealing with those who made them, and who were entitled to accept and act upon it as expressing what it purported to express, to wit, information having a basis in such superior knowledge." Elsewhere in the opinion the matter is explained in other words:

> It is apparent that the facts involved in the statements and representations in question were such as not to be equally available to both parties, were not at hand or within the observation of the contractors, and involved investigations of conditions, study and computations for which expert technical knowledge was required, if not also a search of the minds and purposes of the members of the board. They were made by a party in a position to have, and who assumed to have, not only a superior knowledge, but also a knowledge which had a foundation in expert examination and study, and they were made for the purpose of being acted upon, and promptly acted upon.

If this be good law, it only requires a similar case in this state to forever knock out the irresponsible clause.

It is a confession of laziness or lack of faith in his ability for an engineer to insert the provision that if anything has been omitted from the plans or the specifications, which is required to satisfactorily complete the work, such omission shall be supplied by the contractor without extra compensation. Such a clause might also be urged as justification on a contractor's part for evading the specifications in every possible particular, for as a man who had been up against this very clause once observed: "The contractor is justified in safeguarding his pocketbook if an engineer can insert such a clause simply to safeguard his reputation."

Then there is the clause vesting in the Chief Engineer indisputable power of interpretation of the contract and specifications, and judicial determination as to their execution. This clause presupposes that the engineer is a better lawyer than the courts, or at any rate, makes him paramount. While it is generally thought by contractors that the clause is illegal, it is still retained in many contracts for the simple reason that no satisfactory substitute has yet been discovered.

The methods of arbitration which have been tried have not thus far been as successful as anticipated either in point of economy or rapidity in settling disputes. One great fault with the system of arbitration generally adopted has been in the number of arbitrators appointed, and when two arbitrators fail to agree the case is presented before an umpire. It would seem to be the better way to appoint only one arbitrator and to leave his appointment to some impartial body of high standing, such as the American Society of Civil Engineers, and to stipulate a time limit in which each side must present its case.

Another universal clause is that providing that the work may be suspended, without compensation to the contractor other than an extension of the time equal to the period of suspension—and that he may not claim damages for any delays caused by the failure of the city to provide him with the right of way. Since a time limit is put on the contractor, and liquidated damages for delays beyond the stipulated time, are deducted from his payment, the city should also agree upon liquidated damages which the contractor may recover for any delay caused by the city, for certainly time is as valuable to him as to the city.

This clause respecting suspension of the work has been altered in the new form of contract for highways and paving, recently adopted, the modification allowing the contractor such reasonable expenses as he was put to by the delay or suspension. It has not, however, been changed by any other departments, and the injustice is so palpable that the lead taken by the Board of Estimate's Committee should be followed in all city contracts.

Another peculiar provision is that while the contractor must assume entire responsibility for the safe conduct of the work, and the methods of construction, the engineer reserves the right to approve or disapprove his plans. Before obtaining a contract on the Catskill Aqueduct, the contractor must give satisfactory evidence of his experience and ability to undertake the work, and if subsequently the engineers for the city insert their suggestions into his plans for doing the work, should not the city shoulder the responsibility in the event, say, of the failure of a temporary structure?

An objectionable clause in the sewer contracts is that giving the city the right to connect any sewer or drain with a sewer under construction, and holding the contractor for the maintenance and cleaning of the used portions until the completion of the entire work. This clause should specify that only the connection could be made, and that the sewer itself was not to be used, otherwise the contractor is entitled to damages, according to a recent Court of Appeals decision on this very clause.

Some engineers are too narrow to realize that a specification is a *standard*, and that an approximation to that standard fulfills the contract. The man who rejects masonry because the joints deviate a fraction from the specification, or piles because they are a half-inch under size at the butt, doesn't appreciate that he is standing in his own light—he never becomes a big engineer—he never has *time to learn engineering*—he is too busy inspecting.

In preparing this paper I asked the members of the Association to send in their suggestions and I received not only suggestions but many grievances. One member writes:

> It might be as well to call the attention of the Municipal Engineers to the unfair conditions which often arise in city contracts due to the clause providing that for every day the contractor is delayed by the city he shall be entitled to one day's extension of time and nothing else. In the case of the New York

*Extracts from a paper presented before the Society of The Municipal Engineers of the City of New York, Oct. 25, 1911.

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Public Library, our contract amounted to over $3,000,000. We were prevented from completing our work because the city let another contract for work which had to be done before we could proceed with the remainder of ours.

As our contract was practically completed, our retained percentage, amounting to $450,000, was held for a period of four months, but eventually an arrangement was made with the city whereby we were paid all but $12,000 of the retained percentage, and our bond for the execution of the contract was proportionately reduced. In addition to the loss of interest on $450,000 for four months, we were required to make good any defects in the work which might appear within a period of two years after the receipt of final payment.

Since we were unable to complete the engine room, due to the work of other contractors, until May of this year, we have not yet received the final payment of $12,000. The question now arises as to when the two years' guarantee shall begin. Should the date be when we receive the final payment of $12,000, now due, or should the date go back to April, 1910, when we had practically completed our contract and refrained from doing the small balance of work in the engine room, as an accommodation to the city? Under such conditions you can appreciate that an extension of time of only one day for every day that the city delays the contractor is not adequate compensation for loss suffered.

Another letter in reference to this same public library. The contractor says:

There has been no friction or criticism of our work at any time, but in spite of the fact that the library has been opened to the public for about six months, and the city has had the use of all our work, we have not been able to get our final payment.

The principal difficulty seems to be in having the work properly inspected. Instead of having one thorough inspection, which should be sufficient, our work has been inspected by the architects, by the consulting engineers, by the Department of Water Supply, Gas and Electricity, by some other city departments, the name of which we do not recall, and finally, after all these inspections, still another one is now going on under another consulting engineer for the city. In each inspection trivial things were brought to our attention, which were corrected, but there does not seem to be any end to the inspections. It seems to us that this work could have been inspected as it progressed, and if any fault were to be found we should have been notified at that time instead of letting the present complex state of affairs arise. It also seems to us that there should be but one inspection, as thorough as the city could devise, and once it has been made and any changes recommended carried out, we should be paid.

These letters must strike a responsive chord in the mind of every contractor. The contract should stipulate a reasonable period after the completion when the final payment is to become due and allow interest if the payment is not made at the stipulated time. The interest clause for delayed payments is allowed in the Catskill Aqueduct contracts and has also been inserted in the recently adopted standard contracts for highway and paving work by the Committee of Engineers appointed by the Board of Estimate.

A Comparison Between Street Flushing and street sweeping at Delaware, Ohio, showed a large saving by the flushing system. A committee of the Delaware Commercial Club, with Mr. J. L. Anderson, Chairman, reported the following results in the Delaware "Gazette" of Nov. 11:

The Committee kept most accurate record of the cost of operating the flusher the first week of the 30-day experiment and the final week, Oct. 21 to 26. A meter was attached to the flusher and during the first week of its use 89,100 gals. of water were used at a cost of 7 cts. per 1,000 gals., making $6.24 for water. Man and team with flusher cost $19.60. Clean-up man with team cost $10.50, and broom man $7, making $37.10 for labor. Thus the cost of flushing all paved streets of the city once and the business section twice, all told 1,222,000 sq. ft., cost a total of $43.34, or 35½ cts. per 10,000 sq. ft. Under the old system, the cost of sweeping all the paved streets once a week was $32. The cost of sprinkling all paved streets for one week was $34.08, making the total cost of sweeping and sprinkling $66.08. The cost the first week by the flusher method was $43.34, a saving of $22.74.

The cost of sweeping all the paved streets once a week during the last 23 weeks cost $736. The sprinkling assessment on all paved streets for 1911 was $783.97, making the total cost of sweeping and sprinkling the paved streets $1,519.97. The average cost of flushing all paved streets once and the business section twice a week based on the record of the two weeks of the experiment, was 41 cts. per 10,000 sq. ft. As the period of falling leaves is short, and the cost per 10,000 sq. ft. of single flushing in the business section is only 36⅝ cts., the committee is safe in reducing the average cost for the city to 40 cts. per 10,000 sq. ft. On this basis, the flushing for 23 weeks would cost $1,116.19, effecting the saving of $403.78.

City Engineer Irwin stated that the only question which had been raised regarding any possible damage resulting from the use of the flusher was to the clogging up of catch basins. He stated that he had watched these closely during the experiment and had found that they really kept better opened up since the flusher had been in use than heretofore.

Specifications for a 10-Year Refuse Disposal Contract, Boston, Mass.

For many years the garbage of the greater part of Boston has been treated by the reduction process, for the recovery of grease and fertilizer base; a portion of the general refuse has been sorted for the recovery of paper and other salable wastes, the combustible residue being burned; and the ashes of the city have been disposed of in various ways. The city, if we remember rightly has always or generally collected the three main classes of refuse and delivered them to contractors for final disposition—unless it be that ashes have been got rid of by the city direct.

On Dec. 5, 1911, Mr. Louis K. Rourke, M. Am. Soc. C. E., Commissioner of Public Works of Boston, will receive bids for a ten-year contract for the disposal of refuse from July 1, 1912. The city will deliver the various classes of refuse to four waterfront and two inland stations, to be built by the city for the use of the contractor, and the contractor will transport the refuse therefrom and effect its final disposal.

Alternative methods of disposal may be proposed by bidders for each of the three main classes of refuse, as stated in the portions of the specifications which follow. Bids must be on the yearly lump sum basis for each of the ten years of the proposed contract, and the city is to have the right to buy the contractor's plant at the expiration of the contract.

Transportation of the refuse from the inland stations may be by ordinary or automobile trucks, steam or street railways, but from the waterfront stations it must be in scows of a design satisfactory to the contractor.

For the general guidance of bidders the quantities of the various classes of refuse collected from each of the proposed districts during the year ending Jan. 31, 1911, is given in the invitation to bidders. Totals for the six districts are as follows, the quantities being in tons of 2,000 lbs.: Population on April 1, 1910, 563,000; ashes and rubbish, 296,000 tons; garbage, 53,000; street sweepings, 73,000 tons.

Extracts from the specifications follow:

Final Disposal.

(a) LAND FOR PLANT.—If the Contractor so desires, the City will furnish, free of cost to the Contractor, a lot at Spectacle Island in location and area as shown on plan on file in the office of the Commissioner, and of sufficient area for the location and operation of his plants; and will furnish City water to the Contractor at meter rates. Any plants or structures erected by the Contractor must be in locations satisfactory to the Commissioner and the health authorities having jurisdiction over the proposed location.

(b) METHODS OF DISPOSAL.—Bids may be based on any of the following methods for the final disposal of refuse, or on combinations of the same.

For garbage: (a) by incineration or (b) by reduction.

For ashes and miscellaneous refuse mixed: (a) by incineration; (b) by filling of marsh lands or flats along the harbor front, or on islands in the harbor, when properly bulkheaded to prevent the escape of refuse.

For clean ashes: (a) by dumping at sea; (b) for filling.

Incineration.

If incineration of the refuse be adopted, in whole or in part, the process shall be subject to the following conditions:

(a) DESTRUCTORS.—The Contractor shall erect, maintain and operate destructors of sufficient capacity to handle 50% more refuse than the conditions as shown by the past year's collections call for. He shall determine the capacity required and submit with his proposal complete detailed specifications for the plants.

(b) DESTRUCTOR CAPACITY.—The destructor capacity as guaranteed by the Contractor shall be based upon a specified mixture of refuse. This mixture shall be stated by him in his guaranty and shall conform as closely as possible to the ordinary working conditions. It is to be understood that this specified mixture is simply to establish a basis for making the tests and in no way lessens the Contractor's responsibility to provide a complete plant of sufficient capacity to handle the refuse as delivered to him under the varying conditions pertaining to different seasons of the year.

(c) TESTS.—The guaranteed capacity must be developed, before acceptance, by four tests of at least eight hours each. When making the test the furnaces are to be brought to the normal working conditions before starting, and on ending, the pressure temperatures and furnace conditions are to be brought to the same conditions as when starting. The destructor plant is to be equipped with suitable thermometers and pyrometers for recording the temperatures in the combustion chambers, boiler uptakes, chimney, air-supply, etc. Apparatus for analyzing the chimney gases is also to be provided. All expenses of the tests shall be borne by the Contractor. Under ordinary running conditions, either when testing or at other times, no auxiliary fuel is to be used in the destructors.

(d) VENTILATION.—A positive system of ventilation must be provided, so that the forced draft for the destructor furnaces shall be taken from the vicinity of the storage bins and other places needing ventilation and prevent the escape of unpleasant odors. The design of the destructors must provide setting chambers of such size that the velocity of the gases will be adequately reduced and the dust deposited so as not to escape from the chimney. At no time during the continuous operation of the plant shall the minimum temperature in the combustion chamber be less than 1,250° and the average must be at least 1,600°.

(e) CLEANING.—Ample room must be provided for the cleaning of all flues, dust-settling chambers, boiler tubes, etc., so that the plants may be operated continuously six days each week, one day (Sunday) being allowed for cleaning. The dust chambers, flues, etc., shall be so arranged as to allow of dust being withdrawn after one day's cooling.

(f) GUARANTY.—The Contractor shall state and guarantee the rate of evaporation per pound of refuse burned.

Reduction.

(a) LOCATION.—The Contractor may establish a plant for the reduction of garbage in a location satisfactory to the Commissioner and the health authorities having jurisdiction over the proposed location, but such location shall not be upon the mainland within the City limits.

(b) CONSTRUCTION.—The Contractor shall erect for the operation of his reduction process a fireproof building of brick, stone or concrete, or a combination of the same, of a design satisfactory to the Commissioner and architecturally in harmony with its surroundings. The structure shall be of ample size for the processes and so designed as to admit of extension in all departments without unnecessary reconstruction.

(c) VENTILATION.—The buildings shall be so constructed as to prevent, as far as possible, the escape of disagreeable odors. The arrangement of conveyors, tanks, presses, etc., shall be such that after the delivery of the garbage to the conveyor at the wharf the process shall be continuous and the apparatus so inclosed that the material shall be at no time exposed to the outside air. Ventilation shall be furnished by an approved plant of ample capacity on the vacuum system, and all air removed from the building shall be passed through the furnaces at a sufficiently high temperature to destroy all offensive odors.

(d) POISONOUS OR EXPLOSIVE MATERIAL.—If the Contractor shall use in any part of his process any volatile, poisonous or explosive material, such portion of the process shall be conducted in a fireproof apartment entirely separated from the remainder of the plant.

General.

(a) SANITARY CONDITIONS.—Sanitary conditions must be preserved in all details of the plants, and the Contractor is to be responsible for carrying on the work so that it shall in no respect become a nuisance.

(b) CLAIMS, DAMAGES, ETC.—The Contractor shall be responsible for any claims made against the City for any infringement of patents by the use of patented articles in the construction and completion of the work, and shall save harmless and indemnify the City for all costs, expenses and damages which the City shall be obliged to pay by reason of any infringement of patents so used.

(c) PERMITS.—The Contractor shall obtain and pay for all building and other permits and privileges necessary for the prosecution of his work, including all charges for water.

(d) DISPOSAL OF RESIDUE.—No floating

material and no garbage, nor any solid refuse of garbage after being subjected to treatment, except by incineration as herein specified, nor any offensive liquid, shall be dumped or discharged by the Contractor into waters within the City, nor into Boston Harbor, nor into the water within, that is to say west of, a line drawn from Minot's Light to Egg Rock Light.

(e) FIRE PROTECTION.—Ample apparatus for fire protection of all plants shall be installed and kept at all times in good working condition.

Filling Marsh Lands or Flats.

(a) Only such locations as have been approved by the Commissioner shall be used for dumping ashes and mixed refuse. Suitable precautions shall be taken to protect neighboring premises from flying paper and from all danger of fire on account of such dumps.

(b) CONTRACTS FOR DUMPS.—No contract for such disposal will be approved until the Contractor has furnished to the Commissioner a plan showing the location of his proposed dumps, together with the evidence of his title to the same and calculations showing the sufficiency of such locations for the disposal of refuse during the term of the contract.

(c) DUMPING OF GARBAGE, ETC.—In no case will the dumping of garbage or refuse containing any mixture of garbage be allowed.

Dumping at Sea.

The Contractor may dispose of clean ashes and similar material by dumping at sea in such locations as the Commissioner may designate and under such regulations as may be imposed by the United States authorities having charge of harbor regulation. The dumping of paper, garbage or other floating material will not be allowed, except in cases of extreme emergency, as hereinafter provided.

Failure to Carry Out Contract.

(a) PROCEEDINGS ON CONTRACTOR'S DEFAULT.—All refuse shall be disposed of as herein specified, except that in case of emergencies, such as fire, flood, etc., or extraordinary ice preventing access to his plant with the scows, the Contractor may, without additional cost to the City, use such methods for disposing of refuse as may be approved by the Commissioner, and for such time as the Commissioner may specify or allow; but if in any other case the Contractor shall fail to dispose of the whole or any portion of the refuse as required by the contract, the Commissioner may give notice thereof in writing to the Contractor; and if such failure shall continue after such notice for more than 48 hours, the City, using any labor or materials and, at its option, the whole or any part of the equipment and plant of the Contractor, may do the work which the Contractor fails to do, and the City may deduct from any sums due or to become due to the Contractor under the contract the amount expended by it in performing such work, on the certificate of the Commissioner, and such certificate shall be conclusive as to all facts stated therein. The foregoing provisions shall not exclude other remedies for breach of the contract. If the Contractor from any cause, except fire, flood or extraordinary ice in the water surrounding the City or in Boston Harbor, or process of law, or other extraordinary and unavoidable cause as aforesaid, shall fail for more than five successive days to remove or to cremate or reduce said refuse as required in the contract, or to dispose of the residue or other waste as required, the Commissioner, acting for the City, by notice in writing to that effect, signed by him and approved by the Board of Health of said City and the Mayor, given to the Contractor or mailed to him at the business address given by him to the Commissioner, may cancel this contract; and in case of such cancellation, or the taking possession of property and doing things as aforesaid, any expenses, losses and damages incurred by the City in each and every month of said term of ten years in removing and disposing of the garbage to be removed by the Contractor under this contract, over and above the amount which would have been payable to the Contractor under the contract, shall be paid to the City by the Contractor.

(b) ALTERNATIVE PROCEEDINGS.—If the Contractor shall fail to do any of the work required of him as aforesaid, whether for said five days or for more or less than five days, the Commissioner, acting for the City, instead of canceling this contract or taking possession of the plant as aforesaid, may, at any time while such failure continues, do the work which the Contractor so fails to do, or dispose of said garbage as he deems best, and the Contractor shall pay to the City all expenses, losses and damages incurred by the City thereby; or, if the Commissioner shall not do the work as aforesaid, or cancel the contract or take possession of the plant as aforesaid, the Contractor shall forfeit and pay to the City as expenses, losses and damages incurred by the City through the Contractor failing to do work as aforesaid, a reasonable proportion of the payment for the work for the month in which such failure occurs, as determined by the Commissioner.

Bids must be accompanied by plans of the proposed disposal plants and all buildings must be of fireproof construction.

A New Plan for Dual Water-Supplies.

"Has the Time Come for Double Municipal Water-Supplies: One Naturally Pure for Drinking and Cooking: the Other Denaturized for All Other Purposes?"

The question propounded at the head of this article was the subject of an interesting paper which brought out considerable discussion at the first of the 1911-12 monthly meetings of the New England Water Works Association at Boston on Nov. 8, 1911. The paper was of joint authorship, by Mr. Wm. T. Sedgwick, Professor of Biology and Public Health, Massachusetts Institute of Technology, and Mr. H. P. Letton an engineer now employed in the Sewerage and Water-Supply Division of the New Jersey State Board of Health. The paper was read by Mr. Letton and the discussion was closed by Professor Sedgwick.

In the opening part of the paper attention was called to the fact that ancient Rome had separate water-supplies for domestic use, for the public baths and for the public fountains. Mention was also made of the discussion of dual water-supplies by Mr. Dexter Brackett, M. Am. Soc. C. E., so far back as 1895, in his report on some phases of a water-supply for the Boston Metropolitan District.

As a reason for bringing up the dual supply question again reference was made to the increasing difficulty of obtaining sufficient pure water close at hand to meet the needs of our cities. It was urged health and esthetics alike favor a separate supply of water for drinking and culinary purposes.

Placing total per capita water consumption at 135 gals. per day, 35 gals. were charged by the authors to domestic uses and only 3 gals. to water used for drinking and cooking. If even as much as 10 gals. were allowed for the two last-named purposes it would be possible in most cases, the authors stated, to secure a ground water which would be safer than many supplies now in use.

Heretofore, the insuperable objection to a dual supply has been that many people would persist in drinking the impure water, even though warned not to do so, and although provided with pure water just as convenient of access. This was what happened years ago at Lawrence, with many resulting typhoid deaths.

The two notable and novel proposals made in the paper were: (1) Of the two supplies suggested, waste of the pure water should be restricted by charging a high price for the water and by metering all pure-water services; (2) water from the nearby dangerous source should be denaturized by dosing it with such large quantities of calcium hypochlorite as would make it so objectionable to most people that they would not drink it, while at the same time the water would not be harmful if drunk, neither on account of the hypochlorite nor of its bacterial contents. In fact, the bacteria would be eliminated.

As a sanitary measure such a dual water-supply would be highly commendable, the authors stated; whether economically practicable was not so easy to say. The great economic difficulty would lie in the cost of the distribution system and meters. Finally, the purpose of the paper was to present anew an old subject for discussion.

The paper being thrown open for discussion, a half score persons spoke briefly, either by invitation from the chair or voluntarily. Mr. C. W. Sherman, of Boston, considered the practicability of the plan to depend upon its cost rather than upon inherent engineering difficulties. Mr. R. S. Weston, also of Boston, thought heavy treatment with hypochlorite would increase corrosion.

Mr. French, of Hyde Park, said his town had been using hypochlorite for about a year, following a typhoid scare. The State Board of Health had neither approved or disapproved. About 6 lbs. of hypochlorite per million gallons had been used. No corrosion of pipes had been noted, but there had been corrosion of dosing apparatus.

Prof. E. B. Phelps, of Boston and New York, could see that local conditions might make a dual supply economically feasible, where a bad supply was near at hand and a good one distant.

Mr. Bainbridge, of Quincy, Mass., said that the Fore River Ship & Engine Building Co. had a dual water-supply, one a bad and one a good water. Neither is treated, but they are labeled.

Mr. Kimball, of Boston, remarked that the time is coming when some conservation of potable water will have to be effected. It may be some time before a dual supply will be practicable.

Mr. Cook, of Paterson, N. J., said the plan might pay in some places and not pay in others, but he thought it would be a long time before two systems of supply would be seen. No complaints have arisen from the treatment of 40,000,000 gals. of water with hypochlorite daily at Boonton, N. J., for Jersey City.

Mr. Sherman next arose for the purpose of amplifying his remarks on cost. The cost of the duplicate plumbing necessary for a dual supply would seem to be prohibitive, except for people able to pay for spring water as an alternative. Mr. Allen Hazen, of New York, President of the Association, stated that he was under the impression that plumbing in Boston has cost more than the Metropolitan water system. Mr. Caldwell, on request, estimated the cost of extra plumbing for a dual supply, using brass pipes and not including a meter, at not over $50 for a 12-room house, and in most cases not over $25 or $35.

Mr. John C. Chase, of Derry, N. H., thought the only feasible plan for a dual supply would be the delivery of good water in the residence sections and bad water in the business districts.

In closing the discussion, Professor Sedgwick said that he had long been impressed with the fact that while most of the water consumed is not used for drinking and cooking all must be fit for such use. Some water-supplies are little better than filtered dilute sewage. While he did not belittle the value of filtration he was sure many people would prefer another kind of water.

Every person who uses impure water is likely not only to suffer, but also to be a center of infection.

Turning to the economic side, the speaker recognized the fact that a city with a good supply would not need to consider the dual plan. That plan would be used only in case of bad supplies, and where safe ones of sufficient capacity to supply water on the present plan would be obtainable only at a high cost.

Finally, Professor Sedgwick remarked, the discussion had brought out the objections to the dual plan which might have been expected, and also a considerable expression of opinion n accordance with the views of the authors.

Cost of Water Mains in Place.—The following table is taken from the report of the Board of Water Commissioners of the City of Wilmington, Del., and may be of use in making rough estimates of the cost of water distribution systems under average conditions.

UNIT COST OF WATER MAIN EXTENSIONS INPLACE, WILMINGTON, DEL., 1909-10.

Size.	Number of feet.	Cost of material.	Per foot.	Cost of labor.	Per foot.	Total cost.	Per foot.
*24	195	$757.32	3.88	$591.10	3.03	$1,348.32	6.91
12	874	1,257.24	.439	561.40	.669	1,813.64	2.158
8	10,040	7,603.33	.733	4,106.04	.431	11,714.37	1.164
*6	200	125.79	.628	259.24	1.29	385.33	1.818
6	2,398½	1,601.86	.668	815.32	.34	2,417.18	1.008
4	1,476¾	522.64	.371	571.23	.387	1,093.77	.758
1	287	71.28	.25	49.10	.17	120.38	.42

*Rock excavation.

FIELD AND OFFICE

Demolishing a Reinforced-Concrete Grandstand With a Pile-Driver Ram.

By CLIFF M. STEGNER,* Assoc. M. Am. Soc. C. E.

The reinforced-concrete grandstand of the Cincinnati Baseball Club was the first reinforced-concrete construction of any consequence in this locality, and also the first reinforced-concrete structure here to have outlived its usefulness. It was completed before the opening of the 1901 baseball season by the Ransome Concrete Co. in accordance with what was then known as the Ransome system.

Because of its limited capacity and the desirability of a deeper field the Cincinnati management decided to wreck this stand and build a more commodious one about 90 ft. south and west, thereby providing one of the largest fields in the National League. The contract for both the wrecking of the old stand and the building of the new was let to the Kaps-Brehm Co., Engineers and General Contractors of Cincinnati, O. The razing was begun in early October immediately after the close of the 1911 season.

The principal wrecking appliance was a derrick with a 50-ft. boom and a 3,000-lb. pile-driving hammer (Fig. 1). The derrick was erected on the roof of the grandstand and moved from one end to the other as the wr[illegible] progressed. In operating the derrick the ha[illegible] was raised to the top of the boom and [illegible]tted to fall about 50 ft. and crush the sl[illegible] operation being repeated, wrecking firs[illegible] roof and then the floor. After the d[illegible] had been cleared away, the columns were [illegible]d over with a hoisting engine, which was [illegible]dily accomplished after the farther verti[illegible] column bars had been cut by an oxygen-acet[illegible] flame. All structural material was found [illegible] in a fairly good state of preservation.

FIG. 1. PILE-DRIVER RAM HANDLED BY DERRICK, DEMOLISHING REINFORCED-CONCRETE GRANDSTAND AT CINCINNATI.

The destruction of the building [illegible]forded an excellent opportunity to make comp[illegible]sons between present practice in concrete desig[illegible] and that of ten years ago.

The use of cold-twisted steel r[illegible]inforcement, the concrete mix, and the tensile and compression stresses, were in close conformity with local practice at the present time. It was apparent, however, from the absence of bent tension rods and web reinforcement, together with the fact that the beams were narrow in comparison with their height, that the subject of shear was not thoroughly understood. The weakness in shear was well illustrated when the hammer was dropped sufficiently close to break, but not to crush a beam, when the failure was invariably in the web by horizontal shear or diagonal tension.

Fig. 2 illustrates the roof construction. It shows the deep narrow beams, 5 ins. wide by 20 ins. deep below bottom of slab, on a 30-ft. span, with stiffener strut at the center to prevent lateral motion. The view Fig. 3 shows the construction of the floor and columns below. The latter were 14 × 14-in., reinforced with three ½-in. square twisted bars in each corner without lateral ties excepting 2 × ⅛-in. flat spacing bars located on the bottom, middle and top of each column. The absence of other ties in the columns is plainly shown by the disintegration of the concrete at the corners, and the springing out of the corner bars through their inability to take compression. Fortunately the unit-stress on the columns was never high, and they were able to perform the purpose for which they were intended without danger. A similar inability of the steel to take its strain is shown in Fig. 2 around the box rail, where the concrete broke off and exposed the metal to the weather.

The structure contained two different 1:2:4 concretes, the aggregates being crushed limestone with dust, and washed river pebbles of trap or silicious nature. The former broke into small fragments with considerable dust, while in the latter the pieces were larger with little or no dust.

*Engineer, Department of Buildings, Cincinnati, Ohio.

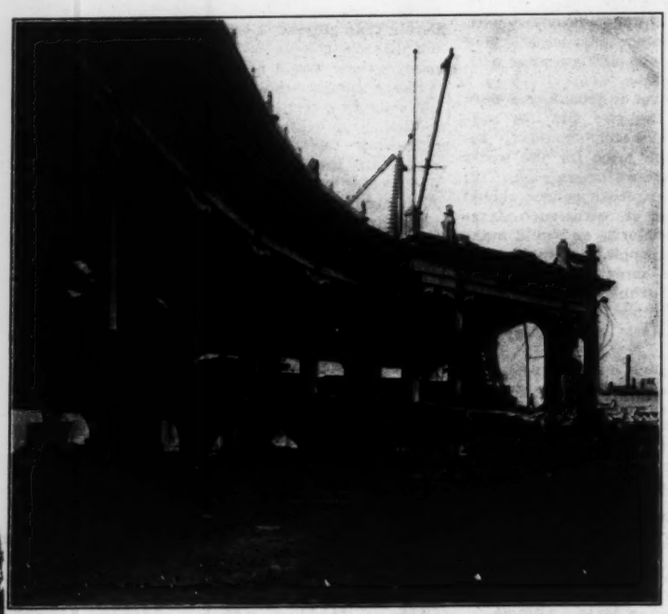


FIG. 2. FRONT OF THE GRANDSTAND, SHOWING ARRANGEMENT OF ROOF FRAMING.

FIG. 3. BACK OF GRANDSTAND, SHOWING FLOOR FRAMING AND COLUMNS.

Renewal of Bridges on the B. & O. R. R.; Rapid Work With Hand Winches.

By CHARLES JOHNSTON.*

During the winter and summer of 1910 the Baltimore and Ohio R. R. completed the renewal of the six remaining bridges of light capacity on the Somerset and Cambria Branch, running from Rockwood to Johnstown, Pa. All of the bridges were erected and placed with but slight interruption to traffic and little or no interruption to the forces engaged in the field erection of the new structures or dismantling of the old structures. The actual placing of these bridges was done in a remarkably short time, and on two of them it is believed that a world's record was established for bridges of this type and weight. All of the work was done by hand power, without the aid of a pound of steam.

Of the six bridges renewed, three (Nos. 214, 216 and 217) cross Wells Creek and the other three span Stony Creek; Wells Creek flows into Stony Creek a short distance below Bridge 217. Both of these streams, and particularly Stony Creek, drain a large mountainous area and are consequently subject to very sudden and heavy floods that sweep before them everything not of a permanent character. For these reasons it was deemed advisable to erect the new spans before placing them in final position across the stream, as this method necessitated the use of falsework under the new structures for the shortest length of time.

The general method of placing these bridges was as follows: A short distance back from the bank and far enough to one side of the track to afford clearance, were erected two framed bents, at right angles to the track and a distance apart equal to the span of the girders. On these were unloaded the new girders in upright position and at proper spacing. The floor system was unloaded nearby where it could be easily handled by the erection gang. The field work of placing the floor system was then carried out as in any structure of this kind where traffic is not to be cared for; rails were also placed in the exact positions that they would occupy when the bridge would be in use. All field work on the girder span being completed, sufficient framed bents (of knockdown type) and longitudinal stringers were placed under the girder and across the stream to provide a trestle on which the girder span could be pulled lengthwise to a position alongside of the old span and about 20 ft. distant. The longitudinal movement was accomplished by the use of the same equipment that was later used for placing the structure in its final position. The work just mentioned was usually done two or three days prior to the final placing of the span. As soon as the girder was across the stream, the intermediate bents were struck and the girder was left standing on the two end bents, which were in line with the bridge seat and with similar bents on the other side of the pier or abutment, the latter being intended to receive the old bridge when the shift was made.

For pulling the structures laterally, three crabs or winches were placed at each end of the span, these resting on the bank, if possible, or on staging erected for that purpose (the accompanying photographs show the winches on staging), the winches being placed so that the line of pull would be as nearly level and in line with the bridge seat as possible. Each winch was connected with the lower part of the girder farthest away, two and three-sheave pulleys being used to augment the pull of the winches. Three or four men worked each winch, depending on the force available. Short blocking was placed between the two structures in order to maintain uniform contact while they were being pulled into position.

At a pre-arranged time, usually after the passing of a certain train, the old structure was jacked up and placed on rollers running on a rail that extended across the bridge seat and bents on either side (the new structure being already on rollers). All four rollers were placed as nearly simultaneously as possible. This being done, the winches were started and the new span was pulled into position, the old truss being shoved ahead of it.

As soon as the rails on the new span were in line with the track at each end of the bridge the winches were stopped and the rollers removed. The girder being lowered to the bridge seat, the four connecting rails were immediately placed, and spiked, and the bridge was considered ready for service.

The old span was dismantled while over the stream, on falsework, using a locomotive crane; the material was loaded directly on to the cars as soon as it was free from its connecting members.

Below are given the times required for moving the six bridges, arranged in the order in which they were placed. It will be noted that each bridge was moved in a little quicker time than the one preceding it, except No. 228, on which a 25-ton jack failed just as the new span was being lowered to the bridge seat, causing a delay of 25 to 30 mins. The best work was done on the fifth and sixth spans placed. The accompanying photographs show the sixth span. The time of 23 mins. on the last span was the elapsed time between the caboose of the train shown in Fig. 1 and the pilot of the engine shown in Fig. 3.

Bridge No.	Approximate weight, tons old span.	Approximate weight, tons new span.	Length of span, ft.	Length of span, ins.	Length of time track was out of service, hr.	Length of time track was out of service, mins.
214	45	80	62	0	1	45
216	45	80	62	0	1	10
217	47	82	64	0	0	47
228	70	130	106	7	1	10
230 (West span)	70	130	106	7	0	30
230 (East span)	70	130	106	7	0	23

The details for moving these bridges were worked out by Mr. W. S. Schenck, Master Carpenter of the Connellsville Division, who was also in personal charge during the actual moving of the structures into place. The same men were used in placing each of the six spans, so that but few orders were necessary during the progress of the work, every man knowing his place and what was expected of him at the next step.

*Dilworth, Porter & Co., Ltd., Pittsburgh, Pa.

Fig. 1. Before Cutting Track.
(Train crossing old span; new girder span on right. In background, west span already shifted.)

Fig. 2. Shifting Old and New Spans.
(Winches on staging at left.)

Fig. 3. New Span in Place.
(Junction rails being placed.)

REPLACING EAST SPAN OF BRIDGE 230, BALTIMORE & OHIO R. R., SOMERSET & CAMBRIA BRANCH; TOTAL TIME BETWEEN TRAINS 23 MINS.

Driving Shallow Sheeting for a Sewer Trench with Steam Hammer.

A contract for laying terra-cotta sewer-pipe in Watertown, N. Y., gave the contractor, Wm. J. Semper, of Watertown, opportunity to use modern sheeting facilities in unusually simple and effective manner. The soil was sandy to a depth of about 10 ft., below which was wet sand mixed with gravel; the sewer pipe was to be laid at an average depth of 15 ft. Sheeting had to be used to hold the sandy soil in excavating the trench, although the upper 5 ft. were taken out without sheeting.

Corrugated sheeting ⅛-in. thick (Wemlinger Type A) in 10-ft. sections was procured, 400 sheets in all, and for driving them a 650-lb. steamhammer driver (McKiernan-Terry 3¼-in. pile hammer) was used. The sheets were carried by hand and set in position on each side on the bottom of the 5-ft. trench, and successively driven by the hammer to about 5-ft. penetration. Excavation and pipe-laying followed.

For handling the hammer a 2-ton Triplex chain block was hung from a wooden A-frame straddling the trench. This was to steady the hammer while driving, and raise it to the top of the next pile, as well as withdraw the sheeting after the trench was backfilled. It was found more convenient, however, to steady the hammer by hand (see photograph), and in fact the hoist could not easily be worked fast enough to follow the hammer down.

Steam-Hammer Steadied by Hand While Driving Steel Sheeting for Sewer Trench.

Only three men were employed placing and driving sheeting. Each sheet was driven in 33 to 37 sec., and the whole time required for setting and driving 32 sheets was about 1⅛ hrs.; this includes carrying the sheets an average distance of 175 ft. Including the time taken for moving the A-frame and hammer, a length of

7 ft. of trench was sheeted on both sides in one hour, on the average.

Steam for the pile hammer was taken from the boiler of a road-roller through a 1-in. pipe a distance of about 125 ft. The pressure varied from 100 to 125 lbs. The driving piston in the pile hammer weighed 70 lbs. and struck 350 blows per minute. The tops of the sheet-piles were protected by means of a special driving hood of soft iron loosely attached to the base of the hammer between its jaws, so that it would not fall off when the hammer was raised. The hammer and driving cap proved entirely satisfactory; although the thin sheets were used continuously during one entire season, not one piece was damaged seriously and the same sheet-piling is being re-used on another sewer job.

The sheet-piling was all driven ahead of excavation. As the trench was dug, it was braced by means of spruce waling pieces, 4 × 6 ins. by 16 ft. long, with struts spaced 7 ft. apart. As fast as the sewer pipe was laid and the trench backfilled, the sheet-piles were pulled, reset and driven.

An Improvised Water Distilling Outfit.

By G. C. SCHERER,* Assoc. Am. Soc. C. E.

Wherever a camp is established which is of a semipermanent nature, the matter of getting pure water presents far less of a problem than when camps are frequently moved. On one of the large construction works on an outlying key on the west coast of Florida, pure water was obtained at small cost by a simple device which furnished a sufficient amount for the supply of some 250 men.

For some time the sole water-supply was obtained from a 5,000-gal. tank which caught rain-water, and by a few driven wells, none deeper than 15 ft. After a time it was observed that mosquitoes were becoming more numerous, and that many of the men suffered from fever and dysentery, and it became apparent that the trouble arose from the water used. The writer suggested the advisability of using distilled water; steam for making it was available from the boiler or from engine exhaust, but the question of a condenser presented for a time an insurmountable obstacle. It was finally decided to improvise one by making a pipe coil, which was done in the following manner.

About 75 ft. of ¾-in. gas pipe was coupled together, a hole bored 8 ins. deep into a convenient tree, and one man after inserting the end of the pipe in the auger hole slowly bent it around and around the tree, forming a perfect though somewhat separated coil. The pipe was then cut off at the surface of the tree with a hacksaw, the trunk of the tree immediately above the coil sawed off with a large cross-cut saw, and the coil removed. It was placed in a water-tight cypress box 6 ft. square.

The exhaust of a small hoisting engine was then connected to the coil, a small cold-water pump led into the box, a barrel placed below the outlet, and the condenser was in successful operation.

In order to aerate the condensed water and to cool it, not having ice, a number of unglazed jugs were filled with this water while still warm, and hung in the passageway of the quarter house. The jugs being unglazed, a certain amount of water percolated the clay, and the evaporation from the moist outer surface of the vessels produced sufficient cooling effect to give the water an agreeable coolness. While standing, the water had a chance to absorb enough air to remove the flat taste.

With the disuse of rain-water trouble from mosquitoes ceased, to the improvement of health as well as comfort. Surface water being no longer used dysentery gave no more trouble.

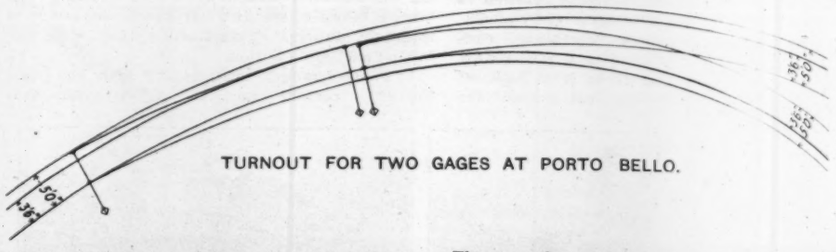
The entire cost of this improvised condenser fully installed did not exceed $15. This, of course, did not include the cost of the cold-water pump, which was selected from a lot of worn-out property but with a small amount of repairs did efficient service for the purpose required.

*U. S. Engineer Office, Montgomery, La.

A Double-Gage Turnout.

A very unusual piece of track arrangement is sketched by C. R. Logan, Cristobal, C. Z., in the drawing reproduced below. It is a turnout in a section of mixed-gage track, where both 3-ft. and 5-ft. gage is maintained on the turnout as well as the main track. He says:

It is so simple that no explanation seems necessary. The key to it is in the use of the single switch-point. Any instrumentman ought to be able to compute it and stake it out for any required frog number and gages, and any trackman to lay it, after a glance at the sketch. The greater part of the credit for this layout belongs to Track Foreman J. D. Harris of this place.



TURNOUT FOR TWO GAGES AT PORTO BELLO.

The sketch shows the curvature considerably exaggerated. With straight track the arrangement appears much less simple.

The turnout sketched is at the west end of the Porto Bello Breakwater stone quarry.

A Cheap and Convenient Stadia Rod.

A new method for the construction of stadia rods, which can be used by engineers generally, has recently been devised by the U. S. Forest Service.

A full-scale print is made of the face design of the rod in black and red on a single piece of white paper, in four sections, each section being 3½ ins. wide and 3 ft. long. A fifth section is printed without figures, which may be used in patching worn spots or in extending the rod to a length of 15 ft. The pattern and figures are the same as illustrated in Engineering News of April 28, 1910, p. 483.

Stadia Rod Scale, U. S. Forest Service. (The even foot marks and figures are printed in red.)

A piece of ¾-in. pine board 3½ ins. wide by 12 to 15 ft. in length and suitably braced is provided, with or without a hinge, as desired. This is given a heavy coat of varnish, and while it is still sticky the dry paper strips are laid on it end to end. When dry the entire rod, including the paper front, is given a coat of varnish, which effectually protects the latter from the weather and from ordinary wear.

In actual use, even under unfavorable conditions, a rod thus made has been found to give good service. If shellac varnish, which can be carried in a small bottle and applied with a rag, is used a rod can be made in fifteen minutes at a cost not exceeding 25 cts.

Until some enterprising dealer puts the paper prints on the market they can be laid out with indelible ink on thin drawing paper. The convenience of having an accurate, legible stadia-rod in pocket form will be appreciated by every one having work to do in rough country.

An English Topographical Survey.

The following is abstracted fr[illegible] an account of the survey of an English esta[illegible]ven by Mr. J. B. Knowles at a meeting of th[illegible]nior Institution of Engineers in London [illegible]May 5, and printed in the July number of th[illegible]ransactions of this society.

The survey was of a country e[illegible] containing 5,000 acres, which area, if square[illegible]ould have a side 2.8 miles long, or a diagon[illegible] miles long. The procedure was in seven operations as follows: (1) reconnaissance, selecting base line and triangulation points; (2) collating apparatus and erecting signals; (3) measuring base line; (4) reading angles of triangulation system; (5) surveying details; (6) locating contours; (7) plotting map of survey.

The triangulation scheme consisted of a network with sides ½ to 1 mile long. An ideal scheme for the given area consisted of 50 stations and 74 triangles, the latter being solved from 222 angles. The calculation of the triangulation system saved 61½ miles of necessarily very accurate measuring. The base line was measured to an accuracy of 1 in 10,000 and the calculations made to the same degree of accuracy (?) without great trouble, while chaining would not have been more accurate than 1 in 500. The base line was laid out between two central stations, and measured with a 300 or 500-link steel tape, and corrected for temperature, pull and slope.

Each triangulation station was marked by a 3 × 3-in. post, 3 ft. long, driven to within 6 ins. of the surface of the ground. Over these were erected tripods with 2 × 2-in. staffs, 6 ft. 6 ins. to 20 ft. in height, with crossed vanes 9 × 12 × ⅛ ins. The whole was put together with screws so as to be collapsible.

Each angle at a station was read twice to 20", and properly adjusted. With a side ½ mile long an error of 20" amounts to 0.388 links, or about 1 in 10,000.

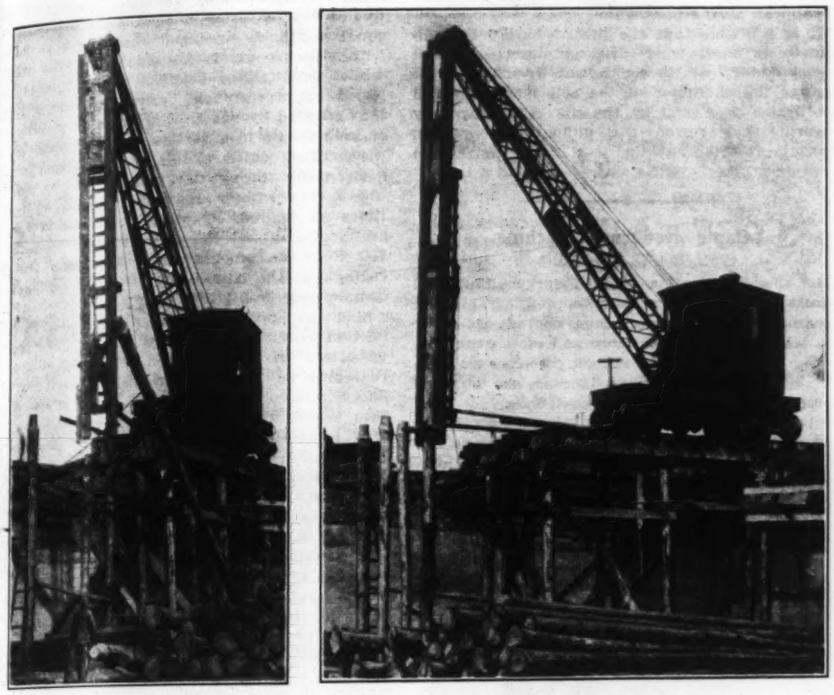
The detail survey consisted of a traverse, afterwards computed and plotted by a method of co-ordinates. This part of the work was modeled after the work done by the British Ordnance Survey, using, however, stations ½-mile instead of 1 mile apart. This 5,000-acre tract therefore required 100 miles of traversing and 80 miles of tie lines. Buildings were tied into this traverse and their ground plans taken. The accuracy of detail thus taken was 1 in 500.

The contours were located by stadia, the outside ring of triangulation points being leveled and the contours interpolated from the stadia points. The contour interval was 10 ft. for 5° slopes and 20 or 25 ft. for steeper slopes.

This 5,000-acre tract was plotted on a sheet 9⅛ × 9½ ft. square on a scale of 2 chains = 1 in. An astronomical observation was made to determine the true azimuth of the base line and the magnetic declination.

The outfit required for so momentous an undertaking was specified as follows: Horse and luggage wagon, two 6-in. transit theodolites with stadia diaphragms, special tape and straining apparatus, one 12-in. level, 4 leveling staves, field glasses, 50 signals and supports, 50 ranging rods, 4 chains and 50 pins, 2 steel tapes, 2 optical squares, a supply of linen tapes, pegs, whites, field books and offset staves. The cost of this outfit new (not including horse and luggage wagon?) was $1,000.

Such a survey was accomplished in from 4 to 6 months by two parties of four men each; each



A LOCOMOTIVE CRANE USED AS TRAVELER AND PILEDRIVER IN BUILDING A PILE TRESTLE.

party consisting of a chief, an assistant and two chainmen. The average time required for the various steps was as follows: Reconnaissance and erecting signals, 2 weeks; base line measurement, 3 days; reading angles (each party 25 stations), 1 week; traversing (each party 2 miles per day, 200 miles), 50 days; locating contours (each party 1 mile per day, 50 miles), 25 days; sum total 4 to 6 months. An average total of 25 acres a day was a very reasonable amount for each party to account for, said the author.

Driving Trestle Piles With a Locomotive Crane.

The two views above show a pile-driving rig which did efficient service in trestle building of the New York, Chicago & St. Louis Ry. (Nickel Plate) for grade-crossing elimination at Cleveland, Ohio. It consists of a locomotive crane of the Brown Hoisting Machinery Co., with a set of driver leads pinned to the end of the boom, and carrying a drop hammer on the regular hoisting rope. The crane had been used in other service on the grade-crossing improvement, and by fitting it for pile-driving, as shown, it handled the trestle construction with great facility; the pictures show it working at the trestle for an elevated switch.

The leads, 25 ft. long, swing freely on the bolts by which they are fastened to the boom; when driving, they are braced to some of the finished work to hold them rigid. Cross-pieces on the back of the leads and an iron bar placed on two hooks at the bottom of the leads across the front hold the pile in position and steady it while it is being driven down.

The hammer rope is used also for hoisting the piles up into the leads, the hammer meantime being held at the top of the guides by a bolt placed by a workman who climbed up a ladder fixed on the side of the leads.

In the work shown, the driving was in ground that was nearly all shale. Piles were driven down 20 ft. (40-ft. piles); four piles could be driven in less than one hour, which the contractor considered very fast working.

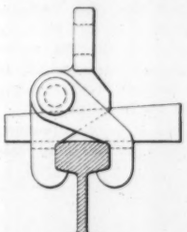
The views show clearly how this rig, standing on the finished trestle track, reaches forward and drives the bent next ahead. A regular pile-driver could not have done the work as simply, and would have cost more.

A New Rail Clamp.

A new rail clamp, invented by W. H. Bates, Superintendent of Steam Shovel Repairs, Empire Shops, Canal Zone, has been adopted after a six months' trial and 350 will be put into service [on the Panama Canal].

The function of this clamp is to act as a stop when a shovel is moving forward, to prevent its running off the end of the track; also to block the truck wheels securely in place when the shovel is working.

The clamp used heretofore was attached to the rail by means of a key driven under the base of the rail, consequently it was necessary to place the clamp between ties. When the track is in mud and water up to the rails the annoyance and delay incident to attaching the clamp are considerable; furthermore, the ties often interfere with locating the clamp where desired.



Rail Clamp Invented by W. H. Bates, Empire Shops, Canal Zone.

The new clamp is fastened to the rail by means of a tapered key of steel passing crosswise over the rail and thus permits the clamp to be set directly over a tie, or any place desired. The key being above the rail avoids the mud and water.

The clamp consists of two steel castings fastened together by means of a heavy rivet which acts as a hinge pin. The hooks bear on the under side of the rail head when the wedge is driven above the rail, and below the hinge pin; thus giving a secure grip on the rail. The cost of the new clamp is considerably less than that of the old style.—"Canal Record," Nov. 1, 1911.

Standardization of Drawings and methods of dimensioning are under consideration by the Society of Automobile Engineers. The items to be standardized include the size and arrangement of the sheets, arrangement of the views and methods of projection, abbreviations for names, materials, cross-sectioning, records of alterations, method of noting working limits, etc. Further information may be obtained by addressing the Secretary of the Society, Mr. Coker F. Clarkson, 1451 Broadway, New York City.

Hints for Drainage Surveys.*

By I. W. HOFFMAN.†

In many localities some drainage work has been done that proved to be no good. Usually it has been done without a survey, and it all had to be abandoned, and the work done over again.

In making preliminary surveys for county drains or drainage districts, I use stations 100 ft. apart, and only drive marker stakes. I take the levels simply on the ground, and when construction commences, put in the pluses and replace the markers, if any have been obliterated. On tile drains I put in plus stations every 50 ft. In that way the profile will be accurate and the exact depth of cut ascertained, or very nearly so. The profile should show the depth of the cut. It is well to put records of bench marks on the profile, as well as the length of drain that passes through the property of the different land owners; also the intersections with different subdivision lines and roads or highways.

The map should be made so as to show the surface conditions of the district (the points of the wet land, low land, or high land) and it should be as nearly accurate as it is possible to make it. The better the map is made, the more easily the board of supervisors can determine conditions in the district. The tracings of the map and profile should be kept by the engineer, and not allowed to be handled by the Board of Supervisors or other persons to any great extent. Blueprints can be made from these and filed in the reports. By the direct white-print process the map is made direct from the tracing and it shows everything plainly. It is made exactly as a blueprint. You do not have to make a negative; simply expose your tracing about seven minutes in bright sunlight, wash it, and you have a white print. You have a map then that can be taken by the commissioners and the classifications can be written on each 40-acre tract.

The engineer should make a complete and comprehensive report to the Board of Supervisors on every drainage district that he lays out. It is better to put in a little too much than not enough, so that the board will fully understand the conditions, the descriptions of the various drains, their approximate cost, and any recommendations the engineer sees fit to make. The engineer should keep a copy of everything that he does in his office. If some of the papers get lost in the auditor's office, which may happen, he then has copies to which he can always refer.

The engineer should try to attend all board meetings, but especially should he be present when the drain is to be established. These board meetings may sometimes be very animated, but he should face the music. It is particularly desirable for him to attend the meetings also when final action is taken on the assessment of benefits. There may be things that the engineer can explain to the satisfaction of the board and to the satisfaction of the land owner.

The engineer should try to accommodate the landowner in all things that can fairly be done. A landowner may wish a slight change sometimes, before the work is finally established or before the report is made. If he can be accommodated without infringing on the capacity or use of the drain, this should be done.

The lines for the drains should be run as straight as possible; at the same time the line of the drain should follow the lowest depression. The engineer is one of the commission to appraise the damages in a drainage district. The damages asked for are sometimes a great deal more than will be allowed by this commission. The commission on damages should use judgment, and not allow any more than is fair and just.

The assessment of benefits is a very hard proposition. The drainage district should be examined very closely, each tract by itself, and all of the facts weighed and sifted until an equitable apportionment can be made by these commissioners. If this apportionment of taxes has been made in a just and fair manner, the board of supervisors should not change it. A great deal of trouble has resulted by boards changing the assessment.

The engineer and contractor should be on good terms always. The engineer should use judgment and have the contractor work to the line, but should not unnecessarily hamper the work of the contractor, who often has a very hard job before him. The drains should be laid out and constructed upon the best lines and no devi-

*From the Proceedings of the Iowa Engineering Society, 1911 (Iowa City, Ia.)

†County Surveyor and Drainage Engineer, Carroll, Iowa.

ation made from them, and they should be constructed in such manner as to do the most benefit to the land. The people are paying for it, and they expect the construction of these drains to be such as will be a benefit to them.

Laying Drain Tile in Treacherous Soil.

By A. M. SHAW.*

The difficulties attending the laying of drain tile through certain classes of material are not only vexatious but often prevent carrying out drainage work which if successfully completed, might be of great value. In two instances, under quite dissimilar conditions, the writer has been able to lay and maintain a line of tile through treacherous material by wrapping the joints with one or two layers of burlap.

In the first case, a wet railway cut was giving considerable trouble due to the stoppage of the drainage in the side ditches by small slides. A tile drain was decided upon, with the idea that this would be below the line of disturbance and would carry off the water and possibly prevent further slides. It was found, however, that the movement of material, while slight, extended down to the tile to a sufficient degree to disturb the line and cause the joints to open and the tile to fill with sediment. That section of the tile which had been disturbed was taken up and relaid on a board bottom, one side of the line of tile also being protected by boards. Common fencing was used, forming an L, in the angle of which the 6-in. tile was placed. Each joint of the tile was wrapped with burlap, a strip one yard in length and a foot wide (folded to 6 ins. wide) being used. It was found that the easiest way to place the burlap was to lay it across the bed of the ditch in advance of the tile, so that after the tile were placed the ends could be brought up and over the top, making nearly two complete wraps around each joint. This treatment proved to be an entire success, though it would probably be of little value in cuts in which a large displacement of material occurs.

To drain a small pond for agricultural purposes, it was necessary to lay a line of tile through a sand ridge, the greatest depth of cut being about 7 ft. Quicksand was encountered for a distance of several hundred feet. This ran into the joints so freely that the tile were soon filled. A repetition of the burlap treatment was again used, with satisfactory results, though the boards were omitted in this case. The tile have now been in place for three years and the owner advises that they have never shown any indication of restricted flow. Through the sand ridge, this line was laid with a grade of less than ½-in. per 100 ft.

The advantages of burlap for use with drain tile as compared with a rigid cement joint are: It is easy of application in cramped quarters; it permits considerable movement without opening the joints to an objectionable degree; and it permits infiltration of the water at joints.

This last point is not always fully appreciated, as it is still the popular impression that "porous" tile are really porous. As a matter of fact, the amount of water that will pass through the walls of a line of tile under ordinary conditions is negligible. Several years ago the writer made a number of experiments to determine the rate of flow through the sides of soft-burned farm tile. Samples were selected from a car of unglazed tile, some of the samples being exceptionally underdone. One end of each tile was sealed and the cylinder filled with water. The surface of the water quickly lowered until there was evidence of moisture on the outer surface of each tile; the rapidity of absorption (but not the amount) appeared to bear some relation to the degree of hardness of the tile. After this initial lowering of the water surface had taken place, each tile was again filled. Any subsequent loss of water in each sample might easily be accounted for by the evaporation from the surface and from the sides of the tile. Certainly not enough water passed through the walls of the tile to cause a stream or even drops of water to appear at the base.

It is probable that the life of burlap is comparatively short when used as described. But the tendency of thorough sub-drainage is to change the character of the soil through which the drains pass, and by the time the temporary covering has rotted the difficulties requiring special protection at the joints may have been overcome.

*Consulting Engineer, 1678 Robert St., New Orleans, La.

Sample Reducing Machine.

By E. W. MILLER.*

As the specification method for making coal purchases is more generally adopted, a rapid and accurate method of preparing coal samples for the laboratory deserves more and more attention.

The usual method of reducing the gross sample, consisting of a hundred or several hundred pounds, is by crushing the coal either by hand or power, mixing thoroughly by shoveling over and over and dividing the pile into quarters, opposite quarters being then discarded. This mixing and quartering process is continued until the desired quantity remains. The crushing, if carried on by hand, may be done in stages, the sample being quartered one or more times before being crushed to the fineness of the final sample. This latter practice probably gives sufficiently accurate results so far as ash and heating value are concerned, and the moisture loss is not so great as if the whole gross sample were crushed to the fineness necessary for the final sample.

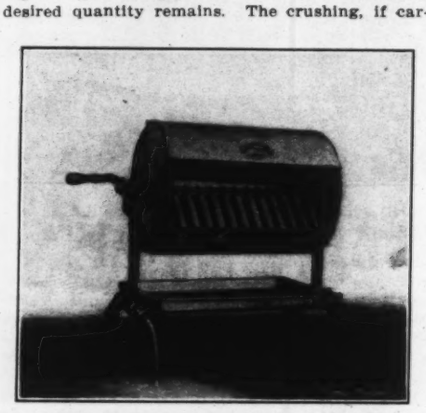


Fig. 1. Machine for Reducing Coal Samples. (Designed by E. W. Miller for the U. S. Bureau of Mines.)

The question of moisture loss is very important inasmuch as the heating value of the coal calculated to the "as received" basis is directly dependent on the moisture content. A power crusher and a mechanical means of reducing the sample are much preferable to hand methods as the work can be done more quickly and the coal is not exposed to air currents.

The mechanical reduction of coal samples has been accomplished by allowing the crushed coal to fall over a series of equally spaced spouts of equal width so arranged that the coal falling within the spouts is discarded from the sample while that falling between the spouts is collected in a receptacle below, the sample being thus reduced by one-half. By placing several sets of such spouts in a vertical chute through which the crushed coal is to fall, each set being turned horizontally through 90° with respect to the set above, the sample may be divided as many times as desired. Thus, if four sets of spouts are provided and the gross sample consists of 100 lbs., the amount finally reaching the receptacle at the bottom of the chute, or the final sample, will be 6¼ lbs.

Such an apparatus is regularly used, in connection with a power crusher by the U. S. Bureau of Mines in Washington. In order that the coal may be thoroughly mixed before being reduced, a revolving cylindrical mixer is also used into which the coal passes from the crusher. The apparatus above described is necessarily stationary, requires considerable head room—about 12 ft. as installed by the Bureau—and the investment in such an installation would be justified only in cases where large numbers of samples were to be prepared.

A portable apparatus, consisting of a pair of rectangular buckets is also used by the Bureau. The buckets are identical in construction, there being at the top of each bucket, near one side, a series of spouts so arranged that as the coal is poured over them, half falls within the bucket and half outside. The repeated dividing of the sample is accomplished by pouring the coal alternately from one bucket to the other. Before reducing a sample by means of these buckets, it must be thoroughly mixed with a shovel or otherwise.

In the machine described below, an attempt has been made to combine the mixing and reducing of a sample in one piece of apparatus which shall be portable and cheap to build, which shall protect the sample from drying air currents, and by means of which the work can be easily and quickly done. Preliminary experiments with this apparatus seem to indicate that these requirements have been fulfilled and it is believed by the writer that it will be found suitable for use either with a power crusher or in those cases where the crushing must be done by hand.

The machine consists of a cylinder of galvanized sheet iron hung on a horizontal shaft passing through its axis by means of which it may be revolved. The cylinder is left open on one side for its full length and for 60° of its circumference, a sliding door concentric with the cylinder being provided to close this opening.

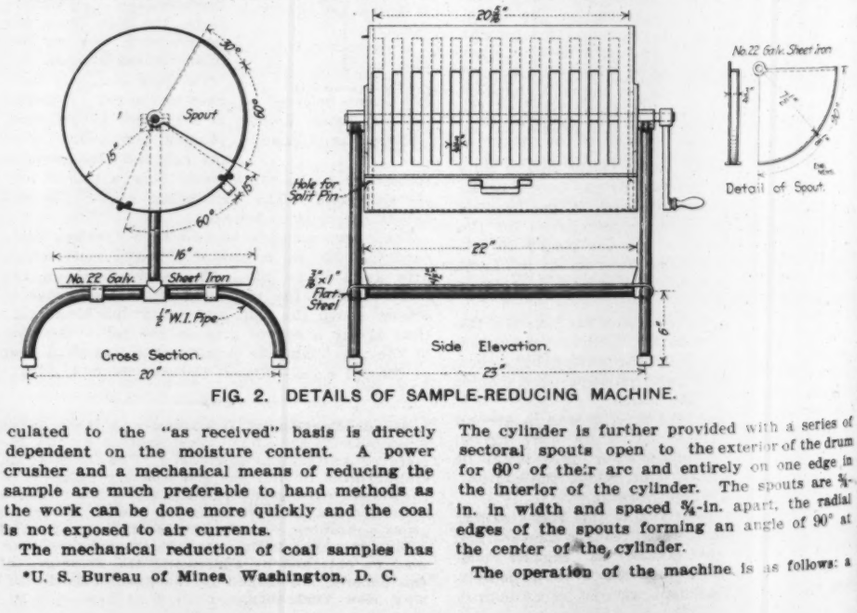


FIG. 2. DETAILS OF SAMPLE-REDUCING MACHINE.

The cylinder is further provided with a series of sectoral spouts open to the exterior of the drum for 60° of their arc and entirely on one edge in the interior of the cylinder. The spouts are ¾-in. in width and spaced ¾-in. apart, the radial edges of the spouts forming an angle of 90° at the center of the cylinder.

The operation of the machine is as follows: a

*U. S. Bureau of Mines, Washington, D. C.

quantity of crushed coal, which should never be more than enough to fill the cylinder half full, is placed therein, the door is closed and the crank turned in an anti-clockwise direction. None of the coal can now fall out, but it will be pretty thoroughly mixed by the repeated ploughing of the spouts, closed side first, through the mass. After several revolutions, the direction of rotation is reversed. There are now presented to the coal a series of vertical planes which divide it into a number of equal portions, each alternate portion falling out through the openings in the cylinder wall. With each revolution of the cylinder in this direction, half of its contents are thus discarded and with a little practice it is possible to judge by the amount falling out each time, when the sample has been sufficiently reduced. When this point is reached, the pan shown in the illustrations is placed under the cylinder and one revolution with the door open, serves to discharge the final sample.

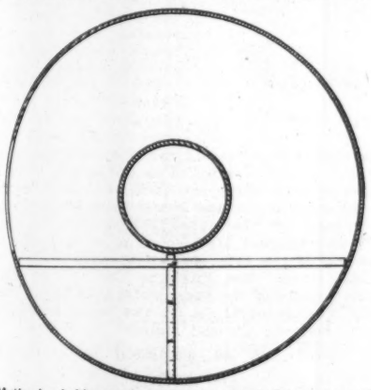
This machine may be built in any desired size. The machine here shown was designed for reducing a 50-lb. sample, the intention being to use it for samples already partially reduced by other methods.

Measuring the Diameters of Internal Cylindrical Surfaces.

By GEORGE W. COLLES.*

It is a frequently occurring mechanical problem to find the internal diameter of some cylindrical construction, such as a pipe, boiler, tank, condenser, etc., to which, on account of its size or location, no convenient calipering method can be easily applied. In some cases, an external diameter can be obtained by taping the circumference, or by constructing a large wooden caliper. Then if the thickness can be accurately determined, the internal diameter is readily computed.

The following method, however, is not only simpler but more accurate, is almost always available, and so far as I know is new. Get a stick of a length somewhat less than the assumed diameter, such as will go inside, and a second shorter stick which can be about half the length of the first. Lay the first stick transversely



Method of Measuring the Internal Diameter of Boilers, Condenser Drums, Etc.

against the concave surface to be measured, so as to form a measure for a chord, and with the second stick held at right anges in the middle, mark off the rise. (See illustration.) This can be repeated in various positions so as to get a fairly accurate average.

Divide the square of the chord by four times the rise, add the rise to the result, and you have the diameter. Example: if the length of the stick is 9, and the rise 3, diameter $= \frac{9\times9}{4\times3} + 3 = 9\frac{3}{4}$. It will simplify operations if the long stick is cut to an even number of inches or feet, and a mark placed in the middle to assist in placing the short stick.

This principle is based on two Euclid propositions, viz.: that the triangle inscribed in a semi-circle is a right-angled triangle, and that the altitude is a mean proportional between the two segments of the base. The half-chord in this case represents the altitude of the triangle, the rise one segment of the base and the diameter the whole base.

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Method of Constructing an Approximate Ellipse With Three Radii.*

By J. J. CLARK.†

The writer offers the following construction of an ellipse by circular arcs in the belief that it is the most accurate yet devised. The method is suited to any ratio of axes from one to infinity; that is, from a circle to a straight line, and it will always give a curve that *looks* like an ellipse. As the title states there are three radii and consequently eight centers.

Draw two indefinite straight lines XX' and YY' at right angles to each other; from their point of intersection C as a center, and half the major and minor axes as radii, describe circles.

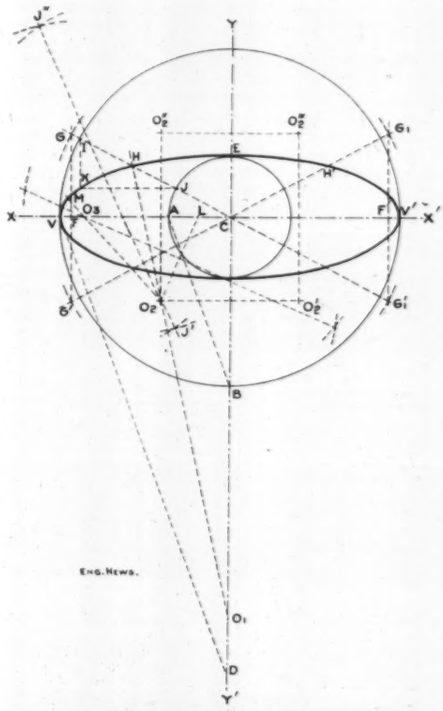


Fig. 1. Method of Constructing an Approximate Ellipse or 8-Centered Oval.

Draw VD parallel to AB, intersecting YY' in D, and lay off $EO_1 = CD$; EO_1 is the radius and O_1 the center of the arc passing through E. Next locate the foci by describing short arcs cutting XX' in F and F', using E as a center and CV as a radius; and through F and F' draw perpendiculars to XX'.

With C as a center and a radius equal to EV describe short arcs intersecting the perpendiculars through F and F' in G, G', G_1', and G_1. Draw GG_1 and $G'G_1$. With O_1 as a center and O_1E as a radius describe HEH' terminated at H and H' by CG and CG_1; draw O_1H.

From I and J, the points of intersection of CG with the circles, draw lines perpendicular and parallel, respectively, to XX' and intersecting at K, a point on the true ellipse. With K and H as centers and any convenient radius describe short arcs intersecting at J' and J''. Draw $J'J''$ intersecting O_1H in O_3 the center for the second arc. Lay off VL, on the major axis, $= O_3H$ and bisect the line joining L and O_3 by a perpendicular that intersects XX' in O_2. Draw O_2O_3M.

With O_3 as a center and O_3H as a radius describe arc HM, terminating at its point of intersection M with O_2M. With O_2 as a center and O_2V as a radius describe arc VM. The remainder of the construction may be performed in a similar manner, but a better way is to obtain the centers O_2', O_2'', and O_2''' by projection. Thus, draw O_2O_2'' perpendicular to XX', and O_2O_2' parallel to XX'. With C as a center and a radius equal to CO_2 describe short arcs intersecting these lines in O_2'' and O_2'; O_2''' is determined by drawing lines through O_2'' and O_2' parallel and perpendicular, respectively, to XX'.

In practice the construction is quite rapid and after a few trials is easily remembered. The closeness with which the curve approaches the true ellipse is marvelous. The ratio of the axes in the figure is about 2.75:1, and for a major axis 5 ins. long the deviation from the true ellipse is scarcely perceptible. With a ratio of the axes of 5:1 and a length of 24 ins. for the major axis it was ascertained that the true ellipse crossed the curve between H and K and again between K and V, thus giving five points of the true ellipse on the quarter curve VHE; at the same time the deviation of the curve from a true ellipse was so slight that in practice it could be entirely neglected, as in the laying out of elliptical arches, etc.

It will be noted that the radius O_1E is directly proportional to the ratio of the axes. Denoting CV by a and CE by b, $CD = O_1E = a \times \frac{a}{b}$.

Likewise $CG = b\sqrt{2}$. When the ellipse becomes a circle, F coincides with C and there is but one radius CE. When the ellipse becomes a straight line C and E coincide and the radius O_1E is infinite. Another point worth noting is that if the centers O_2', O_2'', and O_2''' are determined as recommended above, an accurate determination of the centers O_1 and O_2 is not necessary; an error of 2 or 3% in the lengths of O_1E and O_2H will not appreciably affect the appearance of the curve. The center O_3, however, must be determined accurately.

It is worth while to note the manner in which the center O_3 was found. The problem resolves itself into this: given a circle (or circular arc) of known radius, a chord in it, and a point on the chord, to find the center and radius of another arc which shall pass through the given point, have its center on the chord, and be tangent to the given circle. This problem is of quite frequent occurrence in the drafting room, but the writer has never seen it in any book on drawing or practical geometry.

In Fig. 2, let A G D B F be the given circle, A B the given chord, and C the given point. Find the center O_3 (it is generally known beforehand) in the usual way. With C as a center and a radius equal to O_3A strike a short arc intersecting A B in E. With E as a center and the same radius intersect the given circle in F and G. Draw F G, which is perpendicular to and bisects EO_2; its point of intersection with A B is the center O_3 of the required arc, the radius being O_3C.

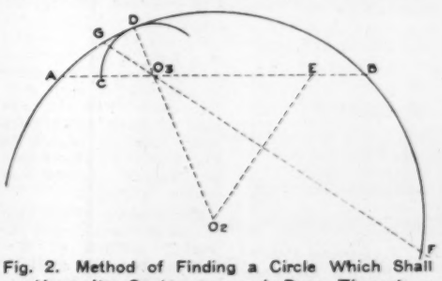


Fig. 2. Method of Finding a Circle Which Shall Have Its Center on, and Pass Through a Given Point on, a Given Chord, and be Tangent to the Circle of the Given Chord.

PROOF.—Draw O_3O_2D and describe arc CD with

*See also Eng. News, Feb. 24, 1910, and April, 4, 1907, for other methods.

†Manager Textbook Dept., International Textbook Co., Dean of the Faculty, International Correspondence Schools, Scranton, Pa.

center O_1 and radius O_1C. $CE = O_1A$ by construction. FG bisects EO_1 at right angles. Since $O_1C = O_1D$, $O_1E = O_1O_2$, and $CE = O_1D = O_1A$. The point D falls on the circle.

Desiring to know to what extent the curve VHE differed from a quadrant of the true ellipse the ordinates in the table below were calculated for an ellipse whose semi-axes were $a = 10$ and $b = 2$. The center C, Fig. 1, is the origin of the coordinate axes. The length of the curve $VHE = 10.51945$, and one-fourth the periphery of the ellipse $= 10.5047$. Area $GVHB = 15.82838$, and one-fourth the area of the ellipse $= 15.70796$.

TABLE SHOWING DIFFERENCE BETWEEN AN 8-CENTERED OVAL AND TRUE ELLIPTICAL CURVE.

Semi-axes 10 and 2.	Approximate ellipse.	True ellipse.	Semi-axes 10 and 2.	Approximate ellipse.	True ellipse.
x	y	y	x	y	y
0	2	2	9	.827	.872
1	1.990	1.990	9.60769[2]	.553	.553
2	1.960	1.960	9.67250[3]	.524	.507
3	1.910	1.908	9.70	.509	.486
4	1.840	1.833	9.75	.478	.444
5	1.749	1.732	9.80	.439	.400
5.77083[1]	1.666	1.633	9.85	.390	.345
6	1.637	1.6	9.90	.326	.282
7	1.458	1.428	9.95	.236	.200
8	1.190	1.2	10	0	0

[1]Abscissa for point H.
[2]Abscissa for point K.
[3]Abscissa for point M.

Reinforcement Around Openings in Reinforced-Concrete Slabs.

Mr. Ernest McCullough, of Chicago, Ill., is disposed to criticise the so-called "right" and "wrong" methods of arranging the reinforcement around openings in reinforced-concrete slabs, as given by Mr. Edward Godfrey in our "Field and Office" section of Oct. 19, 1911, p. 466. Mr. McCullough says in part:

The writer has examined concrete work in a great many cities and in a great many states, but has never seen a plan where the steel was to be placed in the "standard" method shown by Mr. Godfrey, nor has he ever seen it placed in that way. It is the invariable habit of designers and builders to double the steel on either side of the hole, just as the old carpenter referred to by Mr. Godfrey, doubles his joists. The writer does not like the "correct" method shown by Mr. Godfrey, for the reason that this inartistic way of placing the steel will tend to breed carelessness in the steel men on the job. To Mr. Godfrey it may be a "right method," but it is just as much a "wrong

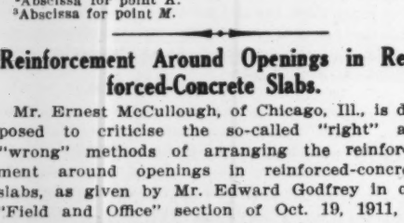


Fig. 1. Fig. 2.

Figs. 1-2. Methods of Placing Steel Around Openings in Reinforced-Concrete Slabs.

method" as that he says is standard. So far as the writer has had an opportunity to judge, the bars which are removed because of the presence of a hole in the floor are placed close to the sides of the hole on each side. The space thus left vacant is then filled with long rods as shown in Fig. 1 or short pieces may be placed across as shown in Fig. 2.

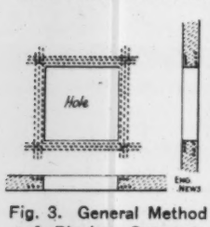


Fig. 3. General Method of Placing Compression Steel Around Openings in Reinforced-Concrete Slabs.

For reasons above given the writer believes the "right" method of Mr. Godfrey is a bad method. Men who are competent to design reinforced-concrete structure are competent to compute the strength of any proper arrangement of steel placed to allow a hole in a slab. Some designers in addition to placing the steel as marked, put short pieces of steel on each side of the hole, using 1 sq. in. of steel for 16 sq. ins. of cross-sectional area of the hole (Fig. 3). This steel is placed in the top, the other steel shown being in the bottom, for tension.

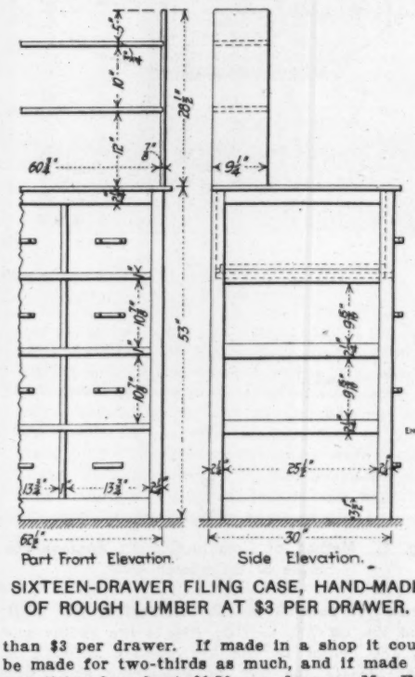
Notes.

A Filing System for Maps Wanted—A correspondent asks for information regarding filing systems for maps:

The system should enable me to file maps of irregular sizes covering the subjects of municipal engineering, land development, and construction work. It should include the method of indexing, and should enable one to find the desired map in a minimum of time.

One map-filing system we have seen makes use of letter file boxes. Each map is folded to a fixed size, about 8 × 11 or 9 × 12 ins. The folding is done so as to bring the lower right-hand corner of the sheet on top; the sheet is first folded on vertical lines, alternately back and forward, and when in this way brought to the standard width it is folded one or more times on transverse lines to make the standard height, this folding also being alternately back and forward. In referring to a map so folded, as soon as it is unfolded vertically any part of the sheet can be referred to by opening only a single fold. The lower right-hand corner of the map, if it does not bear the title, is provided with a label giving title, etc., a serial number and sometimes a small sketch indicating the boundaries of the map. All the maps are then indexed, using the serial numbers to locate the filing case and the particular map. The index entries of course must depend on the specific use to which the files are to be put.

The Cost of a Filing Case made according to the adjoined sketch is given by Mr. Chas. Kirby Fox, Fort Bidwell, Cal., Chief Engineer of the Modoc County Irrigation Co. The case was made wholly out of rough lumber, by hand. It cost a little less



SIXTEEN-DRAWER FILING CASE, HAND-MADE OF ROUGH LUMBER AT $3 PER DRAWER.

than $3 per drawer. If made in a shop it could be made for two-thirds as much, and if made in quantities for about $1.50 per drawer. Mr. Fox further says:

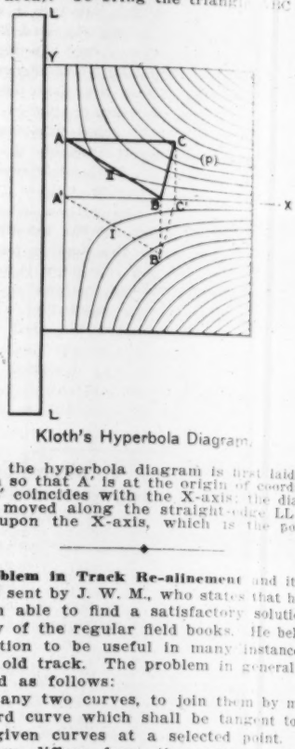
The case looks good and is almost as convenient as a factory-made filing case. The follower works unusually well.

The Hyperbola Planimeter Diagram.—The description of the Beauvais hyperbolic planimeter in our issue of Sept. 21, 1911, p. 340, brings out the following on a related device, by Carl B. Andrews, 743 Wyllie St., Honolulu, Hawaii. It is described in Hammer's "Lehrbuch den Elementaren Praktischen Geometrie," p. 206, and is called Kloth's Hyperbola Diagram. Mr. Andrews says:

The diagram consists of a series of rectangular hyperbolas, or two series of rectangular hyperbolas, as shown in the figure. The curves are described upon a plate of glass or mica (or celluloid), the edges of which are parallel to the axes of the hyperbolas. The diagram must be transparent.

The equation of a series of hyperbolas is $xy = p$, the value of the parameter p being chosen so as to make curves of suitable size for any desired scale of map, and the curves in the series are to be platted sufficiently close to permit of interpolation between them by eye.

If the diagram is laid upon a plan whose area is to be measured, and placed over a triangle ABC so that two angles of the triangle, A and B in the figure, lie upon the two axes and so that the side AC is parallel to one of the axes, the value p corresponding to the position of the point C gives the area of the triangle (or its double area). To bring the triangle ABC in this

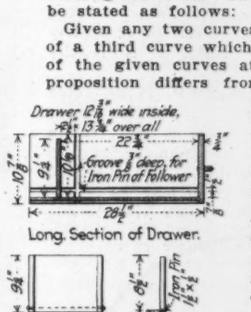


Kloth's Hyperbola Diagram.

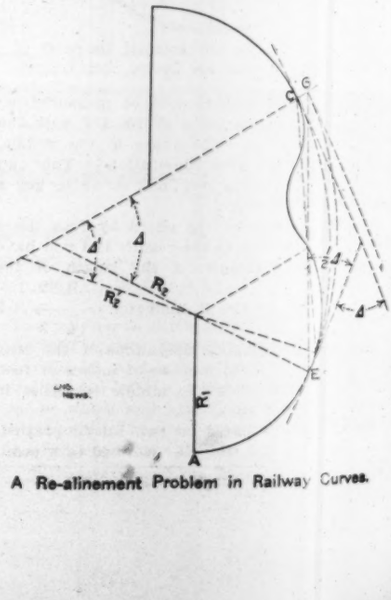
position the hyperbola diagram is first laid upon the plan so that A' is at the origin of coordinates and A'C' coincides with the X-axis; the diagram is then moved along the straight-edge LL until B lies upon the X-axis, which is the position desired.

A Problem in Track Re-alinement and its solution is sent by J. W. M., who states that he has not been able to find a satisfactory solution of it in any of the regular field books. He believes the solution to be useful in many instances of relining old track. The problem in general may be stated as follows:

Given any two curves, to join them by means of a third curve which shall be tangent to one of the given curves at a selected point. This proposition differs from the ordinary one of: Given two curves joined by a common tangent, to replace the tangent by a curve compounded with the given curves; for we need not know the position or the length of the common tangent. The required fieldwork is simple, and does not involve determining the common tangent.



The total angle between the tangents of the two given curves can be determined from their azimuths. Then having run one curve out to the point C, which is selected as the tangent point of the compound curve, we start at the farther end of the other curve and run it in to some point E. Now turn off the chord EG, making an angle with the tangent at E equal to ½ the angle remaining of the total deflection angle of the compound curve. The angle is then ½ the intersection angle of the curve subtended by the chord EG. The point G is on the same radial line as C. Measure CG and compute the radius of the



A Re-alinement Problem in Railway Curves.

curve of which EG is the long chord, knowing as we do the central angle.

Tangents to the curves at C and G will be parallel, so that we now have the common problem found in all field books: Given a compound curve terminating in a tangent, to change the P.C.C. (E), and also the last radius (of the curve EG) so that the curve shall end in a parallel tangent at a point on the same radial line as before. The formulas for the solution of this are:

$$\text{Tan } \tfrac{1}{2}\,\Delta' = \text{Tan } \tfrac{1}{2}\,\Delta - \frac{p}{(R_2 - R_1)\sin\Delta}$$

$$R'_2 = (R_2 - R_1)\frac{\sin\Delta}{\sin\Delta'} + R_1;$$

in which Δ' is the intersection angle for the curve to be found; Δ the intersection angle for the assumed curve EG; p the distance CG; R_1 the radius of curve AE, and R_2 the radius of the assumed curve EG, and R'_2 the radius of the required curve. (See Searles "Field Engineering," Prop. 170.)

(For a number of other similar curve problems the reader is referred to an article on "The Application of the Traverse Method to Railway Curve Section" by Mr. W. C. Willard, of the Southern Pacific Ry., Engineering News, Sept. 30, and Oct. 28, 1909, and to numerous letters in the issue of March 15, 1906.)

A Table for Areas of Circular Segments.

A handy formula for areas of circular segments, and a reference to Mr. Edward Godfrey's table of coefficients of segment areas, were given in our issue of Oct. 19, p. 471. E. H. Wilcox, of Los Angeles, Cal., now sends a coefficient table which supplements Godfrey's table advantageously. The latter has for its entry function the half-angle of the segment, in integral degrees; for each, the ratio of rise to chord is stated, but this ratio naturally is fractional in all cases.

Mr. Wilcox's table gives coefficients for integral values of rise ratio, varying by 100ths up to 0.50 (corresponding to the full semi-circle). Coefficients are given to five places, as against four places in Godfrey's table. Values intermediate between tabular figures can be found by interpolation, as the variation between successive points is very close to rectilinear.

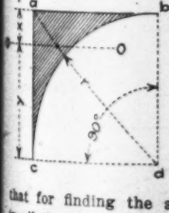
AREAS OF CIRCULAR SEGMENTS.
(Area of segment = chord × rise × coefficient.)

Rise ÷ chord.	Area, coeff.	Rise ÷ chord.	Area, coeff.	Rise ÷ chord	Area coeff.
0.01	0.66668	0.21	0.68963	0.41	0.74920
0.02	0.66686	0.22	0.69181	0.42	0.75296
0.03	0.66714	0.23	0.69408	0.43	0.75680
0.04	0.66752	0.24	0.69644	0.44	0.76071
0.05	0.66800	0.25	0.69890	0.45	0.76469
0.06	0.66859	0.26	0.70144	0.46	0.76870
0.07	0.66928	0.27	0.70407	0.47	0.77278
0.08	0.67007	0.28	0.70678	0.48	0.77693
0.09	0.67097	0.29	0.70958	0.49	0.78113
0.10	0.67197	0.30	0.71245	0.50	0.78540
0.11	0.67307	0.31	0.71541		
0.12	0.67428	0.32	0.71845		
0.13	0.67559	0.33	0.72157		
0.14	0.67700	0.34	0.72477		
0.15	0.67851	0.35	0.72804		
0.16	0.68012	0.36	0.73138		
0.17	0.68183	0.37	0.73481		
0.18	0.68364	0.38	0.73830		
0.19	0.68554	0.39	0.74186		
0.20	0.68754	0.40	0.74550		

Formulas for Elements of 90° Fillet Sections.

By H. C. WEAVER.*

When figuring the section moduli of machine members, fillets often enter into the composition of the sections, in which case it is necessary to know the position of their centers of gravity, their areas, and their moments of inertia about their neutral axes. The absence of formulas for deriving such information, with the exception of that for finding the areas, is very conspicuous in all the handbooks in common use to-day.



A simple derivation of the formulas for 90° fillets is given herewith.

Let r = the radius of a 90° fillet,
A = the area of the fillet section,
x = distance from its center of gravity to the back of the fillet,
y = distance from its center of gravity to the tip of the fillet,
and I_{oo} = moment of inertia of the section about an axis through its center of gravity parallel to the back.

The area is:

$$A = r^2 - \frac{\pi r^2}{4} = r^2\left(1 - \frac{\pi}{4}\right)$$

$$A = .2146\, r^2 \quad \ldots\ldots\ldots\ldots (1)$$

The center of gravity is located by use of a theorem on solids of revolution:

$$\frac{4\pi r^3}{3} = \text{Vol. of a sphere of the radius } r$$

$$2\pi r^3 \parallel \text{Vol. of a circumscribed cylinder.}$$

$$\tfrac{1}{2}\left(2\pi r^3 - \frac{4\pi r^3}{2}\right) = r^2\left(1 - \frac{\pi}{4}\right)2\pi y$$

or

$$\frac{\pi r^3}{3} = r^2\left(1 - \frac{\pi}{4}\right)2\pi y$$

or

$$y = \frac{r}{1.2876} = 0.77664\, r$$

from which

$$x = .22336\, r \quad \ldots\ldots\ldots\ldots (2)$$

The moment of inertia is found by difference from the circumscribed square and the quarter circle:

$$I_{oo} + .2146\, r^2\,(.77664\, r)^2 = \frac{r^4}{3} - \tfrac{1}{4}\,\frac{\pi r^4}{4}$$

or

$$I_{oo} + 0.12944\, r^4 = 0.13698\, r^4,$$

whence

$$I_{oo} = .007544\, r^4 \quad (3)$$

It is uniform practice among certain locomotive builders to use ¾-in. fillets at the junction of the web and flanges of I-section connecting rods. In connection with the figuring of these rods the following table will be of considerable assistance.

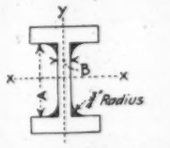


TABLE OF MOMENTS OF INERTIA FOR FOUR ¾-IN. FILLETS.

A"	Moment of inertia axis x — x	B"	Moment of inertia axis y — y
2	.3443	½	.0937
2 ¼	.4523	¾	.1517
2 ½	.5755	1	.2247
2 ¾	.7135		
3	.8671		
3 ¼	1.0355		
3 ½	1.2191		
3 ¾	1.4167		
4	1.6315		
4 ¼	1.8599		
4 ½	2.1039		
4 ¾	2.3623		
5	2.6375		
5 ¼	2.9299		
5 ½	3.2295		
5 ¾	3.5499		

Area = .1207 × 4 = .4828

A set of tables similar to the one above and embracing a wider range of values for A and B, including several different sizes of fillets, would form a valuable addition to the contents of an engineer's pocket-book.

A Method of Treating Blueprints so that the following objects may be attained is desired by F. W. S.: A part of the print is to be made white so that changes may be made in black India drawing ink; the balance is to be treated with some other solution which will render the white lines brown and the rest of the print white, and some surface varnish is to be applied which will render the paper translucent, so that ordinary blueprints may be made from it. Our correspondent believes that some such process exists and would like to hear from readers who have experimented.

A Blueprint May Be Made Brown by first treating it with a solution of 1 part ammonia to 9 parts water (by volume) until the paper is white, and then immersing in a bath of 120 grains of tannic acid to 12½ oz. (liquid) of water for from 10 to 15 mins. The white lines may be made translucent by treating the paper with melted paraffin or a solution of paraffin in benzine.

Diagrams for the Design of Forms for Concrete Slabs.*

By R. C. YEOMAN.†

An ideal form for concrete should be (1) strong, (2) smoothly surfaced, (3) water tight, (4) non-absorbent, (5) easily worked or constructed, (6) light in weight, (7) cheap, (8) and easily removed without injuring itself, the concrete, or workmen.

Wood in its natural state has fulfilled most of the above requirements. Its weak points are usually overcome by some simple treatment, for instance: It is very absorbent, but a little oil or paint applied to it practically eliminates this difficulty. Numerous species of timber are used for concrete forms, their selection depending on the above eight qualities. Usually cheapness, strength, and ease of working are the most important factors. Short-leaf yellow pine has been used widely and will be the species selected for basis of the following calculations.

In presenting tables or diagrams for design it is assumed that the material is uniform in quality. It is impossible and impracticable to incorporate in the diagrams the solution of the dozen or more defects a piece of timber may have, so the designer is called upon to solve special problems to overcome these defects, if there are any. The average man, who will use such a scheme of design cannot do this, and must therefore depend upon a uniform quality of material or risk failure.

A wooden form is made up of a number of beams and columns joined together with nails, bolts, clamps, or wires. Simple beams and columns are easily designed, but when they are dependent on the strength of joints, made with nails, bolts, etc., the problem becomes complex.

The T-column was designed and patent applied for by Mr. D. B. Luten several years ago. He has used it successfully in reinforced-concrete arch forms since. Its design is unique in embodying so many of the requirements for an ideal column to be used in concrete forms. (1) It is simple and cheap in construction; (2) the T-section increases the radius of gyration over the rectangular section adding stiffness; (3) the wiring of members makes them easily removed, and (4) if the wires are cut the separate parts buckle, lowering the structure slightly and allowing the concrete to settle and assume its load gradually, still giving necessary support until safety is assured against sudden collapse, if concrete be defective. This method will take the place of wedges commonly used in arch forms.

The particular problem presented here is a design of a form to support a reinforced-concrete slab. The same scheme is also successfully used in reinforced-concrete arch forms, where it had its origin. The floor slab is chosen for its simplicity of construction. A typical reinforced-concrete floor panel is shown in Fig. 1. This will be a panel, say 12 × 24 ft. c. to c. columns. The forms are built in smaller panels according to methods to be explained. The arrangement is apparently very simple, a block of concrete on a floor supported by paneled joists and columns. The concrete is usually uniform in thickness and weighs from 130 to 140 lbs. per cu. ft., adding about 3% in weight for steel, it is 135 to 145 lbs. For uniformity and safety, use 150 lbs. per cu. ft. To select the most economical lengths of spans for flooring and joists the diagrams shown in Fig. 2 will be consulted.

Fig. 2 is a combination of diagrams so arranged to perform all the mathematical operations of design graphically. At the bottom of the plate are the lagging curves, whose ordinates (on AA') are equal to the span of the lagging or spacing of joists in feet and abscissas (on AB) are equal to depth of concrete in inches or weight of concrete in lbs. per sq. ft. The middle panel of the plate contains a more complex diagram. The abscissas ($A'B'$) are the same as in lagging diagram (AB) but ordinates on the left ($A'L$) represent the load in lbs. per ft. on joists or in Fig. 1 the weight per ft. of length of the block of concrete shown on the front. The lines radiating from A' are arranged to give spacing of joists; by the aid of these it will be seen later that the total weight of the concrete block (Fig. 1) or any panel load is obtained on abscissas ML just above the radiating lines. At the right of the center is a diagram for the design of depth and thickness of joists for any given load (shown on ML) as of columns and one for area of cross-grain bearing.

Above the line ML are plotted two sets of

*Baldwin Locomotive Works, Philadelphia, Pa.

*From "The Engineering Annual," No. 1, May, 1911. Published by the Civil Engineering Society of Valparaiso University.

†Professor of Civil Engineering, Valparaiso University, Valparaiso, Ind.

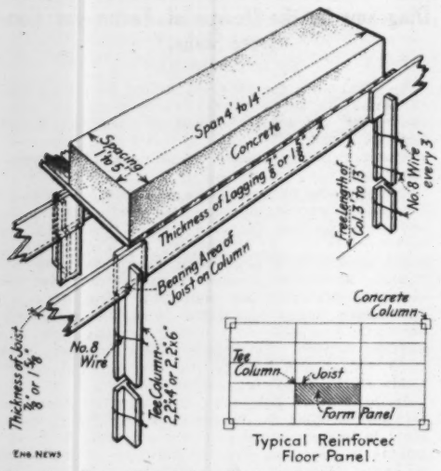


Fig. 1. Form Panel for Typical Reinforced Concrete Floor.

curves; one for strength of columns and one for area of cross-grain bearing. The column curves are made from (*ML*) panel loads as ordinates and length in feet as abscissas (*MP*). Curves for 1 × 4-in., 2 × 4-in., 1 × 6-in., and 2 × 6-in. timbers are plotted to be used in design of sway bracing. The T-columns made up of two 2 × 4-in. or two 2 × 6-in. sticks are a special design for panel support and will be treated in full later. The crushing cross-grain curves are used to investigate safety of joint between column and joists in bearing. Its ordinates are equal column loads in pounds and abscissas are equal to safe bearing area for that load in square inches.

The allowable fiber stress in beams is assumed at 1,000 lbs. per sq. in. This is low, but the water from the concrete weakens the timber sometimes one-half. Also live loads, such as occur in placing concrete, are often excessive and require part of the allowance for safety. The allowable fiber stress in the columns (1,600 lbs. per sq. in.) is somewhat greater as they are assumed to be more free from the water. Cross-grain bearing is taken as 400 lbs. per sq. in. as the usual safe strength. All lumber is considered planed, although the columns might well be rough and increase the strength and safety.

EXAMPLE.—Assume the building plan in Fig. 1 to be 12 ft. 6 ins. × 24 ft., the concrete 12 ins. thick and the height of floor above ground 10 ft. Select economical design of form.

The most economical form will be one in which every part is a regular commercial size and is carrying its maximum safe load or stress. Turning to Fig. 2, find on *AB* the depth of concrete 12 ins.; project this point on each of the two lagging curves to points *c* and *d*, respectively, thence to the left *AA'*; for the ⅞-in. thickness (point *c*) the maximum safe spacing is found to be 2.6 ft.; for the 1⅛-in. (point *d*), 4.9 ft. The choice of spacing may or may not fall on one of these values, but should come as near as possible for economy. Proceed from *c* and *d* upward to *A' B'* to point *e*, where the 2.5-ft. spacing line intersects; follow the dashed line to the right to *F* where the 8-ft. length of joint crosses, thence upward to *c* on *LM* and read the total panel load, 3,000 lbs. One joist must carry this load and its cross-section is next to be selected. Retrace the dashed line to where the 8-ft. length abscissas from *MB'* crosses. This point falls on the safe side and near to 1⅝ × 12-in. section curve, which will be used. This then determines the joists in size, length, and spacing, which are 1⅝ × 12 ins. × 8 ft. and spaced 2 ft. 6 ins. c. to c. Other selections may also be made and compared, but it will be found that the above will prove as economical as any.

The columns are next designed. Again follow dashed line upward to where it intersects with the 10-ft. abscissas from *MP*. This point (not marked by letter on diagram) falls outside of T-column made of two 2 × 4-in. sticks, therefore two 2 × 6-in. sticks must be used.

The bearing area between the joists and column is equal to 1⅝ × 6 ins. plus [illegible] × ⅝ ins., or 10.8 sq. ins. The required area is found by tracing the dashed line from *g* to the intersection of the cross-grain bearing curve, thence to the left to *LN*, and read 7½ sq. ins., which is less than the actual area as is required for [illegible].

If, however, sway bracing and [illegible]s are introduced, the length can be reduced one-half or to 5 ft., free length. Then to design column for 5 ft., retrace from *i* to the 5-ft. [illegible] at point *j*. Running to the loft from *j* [illegible] intersect with the two 2 × 4-in. T-column curve [illegible], then to *k* on *LM*, it is found that a 5-ft. column will carry 8,000 lbs. Two panels can be combined, thus loading column to 6,000 lbs. The size of the tie plates is determined on Fig. 3. Beginning at 3,000 lbs. load or *G'*, proceed to the right to 5-ft. span, *H*. There is no curve above it; therefore no single timber listed is strong enough. We use two timbers start at (½ × 3,000) or 1,500 lbs. load or *G'*, proceed to right to 5-ft. span, or *H*. The full-line curve just above it is for 1⅝ × 10-in. tie, which will be selected.

(Note: Full-line curve is used when tie supports two panels, dashed line curves when supporting three panels.)

The two designs will now be compared for economy of material. The first will require per panel:

two 2 in. × 12 in. × 10 ft. 20.0 board ft. for columns
two 2 in. × 12 in. × 10 ft. 20.0 board ft. for joists.
five 1 in. × 6 in. × 8 ft. 20.0 board ft. for flooring.
one 1 in. × 4 in. × 16 ft. 5.3 board ft. for bracing.
Total..... 65.3 board ft.

The second:

two 2 in. × 4 in. × 10 ft. 13.3 board ft. for column.
one 2 in. × 12 in. × 10 ft. 20.0 board ft. for joist.
one 2 in. × 10 in. × 7 ft. 12.0 board ft. for tie plate.
one 1 in. × 4 in. × 16 ft. 5.3 board ft. for sway bracing.
four 1 in. × 6 in. × 8 ft. 20.0 board ft. for flooring.
one 2 in. × 4 in. × 5 ft. 3.3 board ft. for tie bar.
Total..... 73.9 board ft.

The first uses less material and less number of pieces, which requires less labor and is therefore cheaper and best. Possibly, if three panels could be combined in one column, the second method would prove more economical. This solution will be left to the reader.

With the aid of the diagram the work is so quickly done that, several combinations of spacing, spans, sizes, etc., can be tried until one is found in which every member is loaded to the maximum. However, this might require odd sizes and lengths which would increase the waste of material and labor in cutting to more than offset the saving in actual timber necessary to carry the loads. Therefore, the commercial sizes of timbers available must be considered and all dimensions should be as near simple integral quantities as possible to facilitate the workman in cutting and using the material economically.

No allowance has been made for nailing or fastening the joints. This would ordinarily be a great factor in the design. The estimates on strength of nailed joints are so unreliable and so difficult that the tendency is to eliminate them wherever possible. Also the timber is so badly injured in breaking these joints, when the forms are removed, that the waste becomes excessive. Clamps and wires are becoming more popular because they are easily removed and do not injure the timber. The design in Fig. 1 makes use of wire and a few nails for binding together of parts only. The nails do not carry any load direct and therefore are not considered in the diagram.

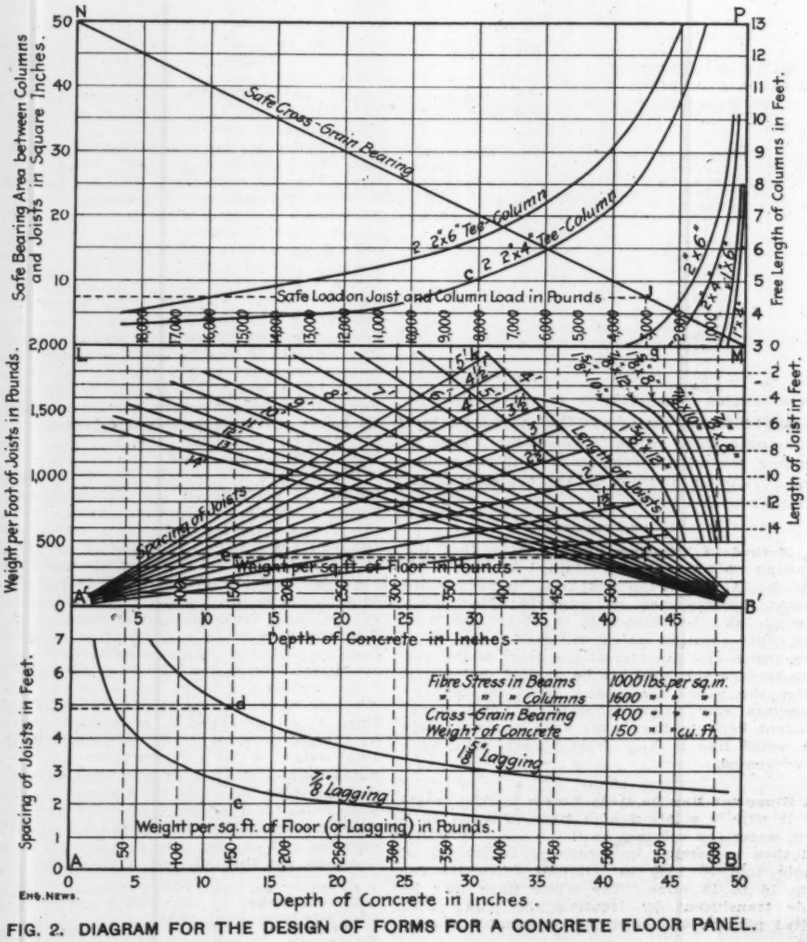

Safe Bearing Area between Columns and Joists in Square Inches.
Safe Cross-Grain Bearing.
2 2"x6" Tee-Column
2 2"x4" Tee-Column
Safe Load on Joist and Column Load in Pounds
Free Length of Columns in Feet.
Length of Joist in Feet.
Weight per Foot of Joists in Pounds.
Spacing of Joists
Weight per sq. ft. of Floor in Pounds.
Depth of Concrete in Inches.
Fibre Stress in Beams 1000 lbs. per sq. in.
" " " Columns 1600 " " "
Cross-Grain Bearing 400 " " "
Weight of Concrete 150 " " cu. ft.
⅞" Lagging
1⅛" Lagging
Spacing of Joists in Feet.
Weight per sq. ft. of Floor (or Lagging) in Pounds.
Eng. News.
Depth of Concrete in Inches.

FIG. 2. DIAGRAM FOR THE DESIGN OF FORMS FOR A CONCRETE FLOOR PANEL.

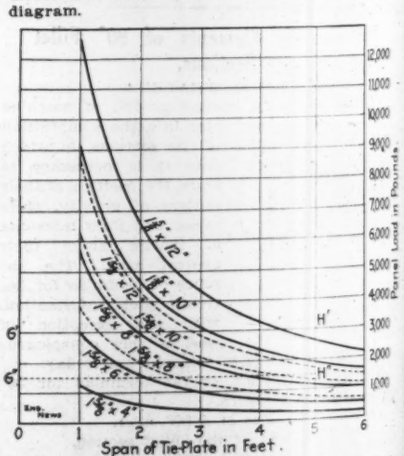


Fig. 3. Diagram for the Design of Tie Plates in Concrete Panel Form.

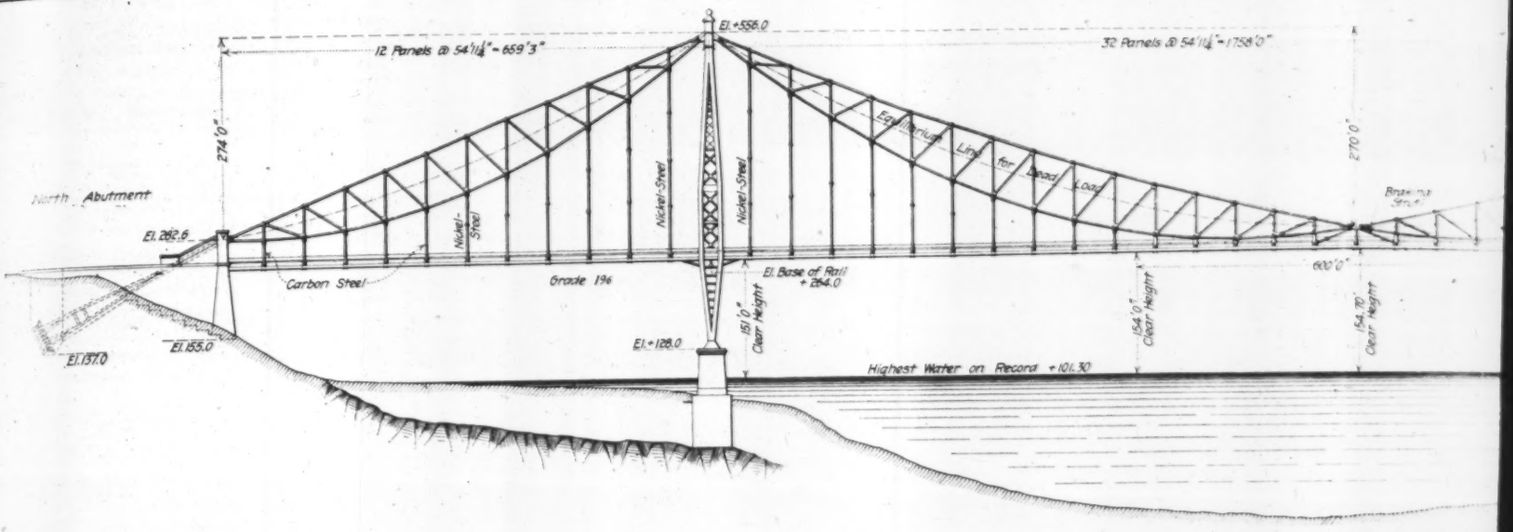


FIG. 4. GENERAL ELEVATION

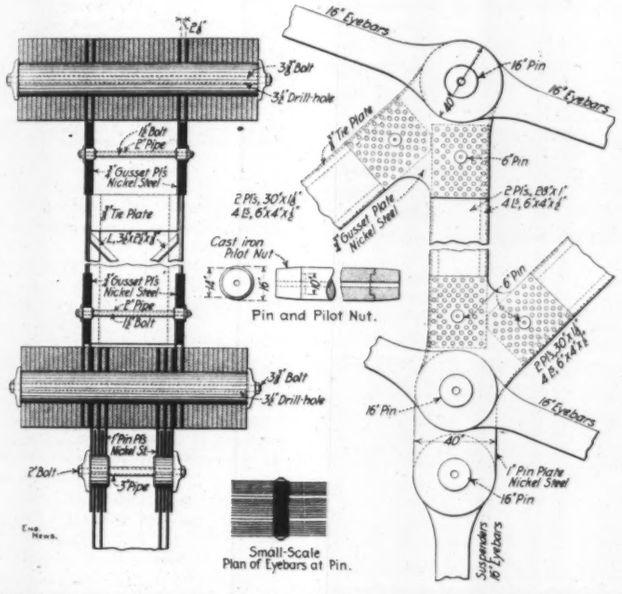


FIG. 6. DETAILS OF SUSPENSION-CHAIN JOINTS AND WEB MEMBERS.

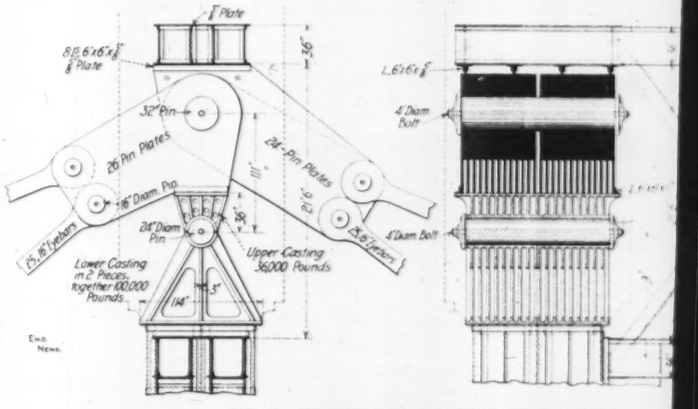


FIG. 7. TOWER-TOP BEARING OF CHAINS.

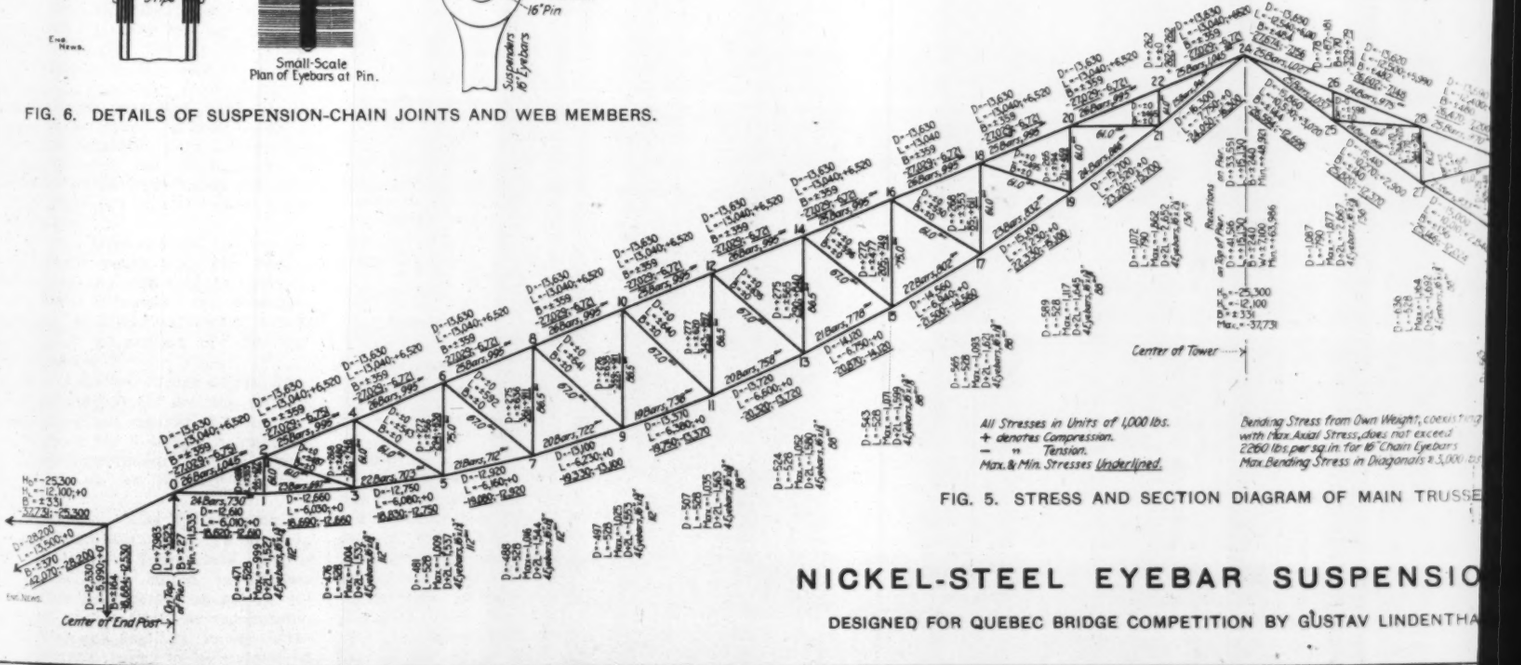
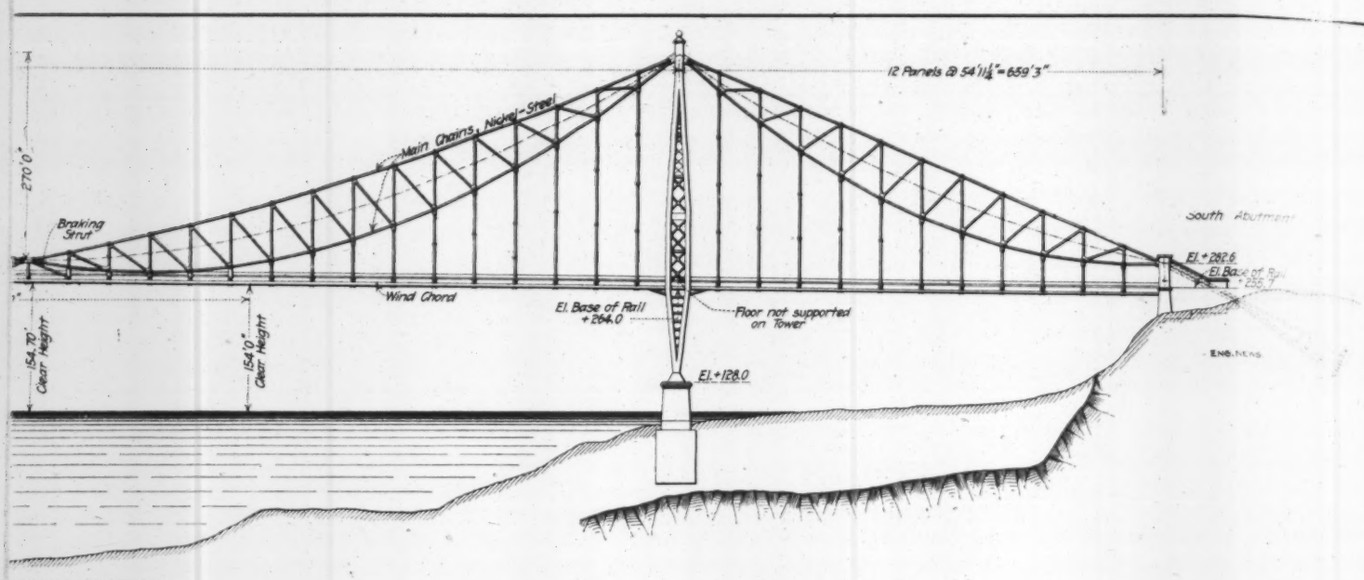

Center of End Post
Center of Tower
All Stresses in Units of 1,000 lbs.
+ denotes Compression.
— " Tension.
Max. & Min. Stresses Underlined.
Bending Stress from Own Weight, coexisting with Max. Axial Stress, does not exceed 2260 lbs. per sq. in. for 16" Chain Eyebars
Max. Bending Stress in Diagonals is 5,000 lbs.

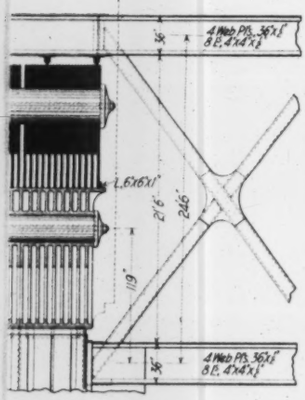
FIG. 5. STRESS AND SECTION DIAGRAM OF MAIN TRUSSE

NICKEL-STEEL EYEBAR SUSPENSIO

DESIGNED FOR QUEBEC BRIDGE COMPETITION BY GUSTAV LINDENTHA



ERAL ELEVATION.



CHAINS.

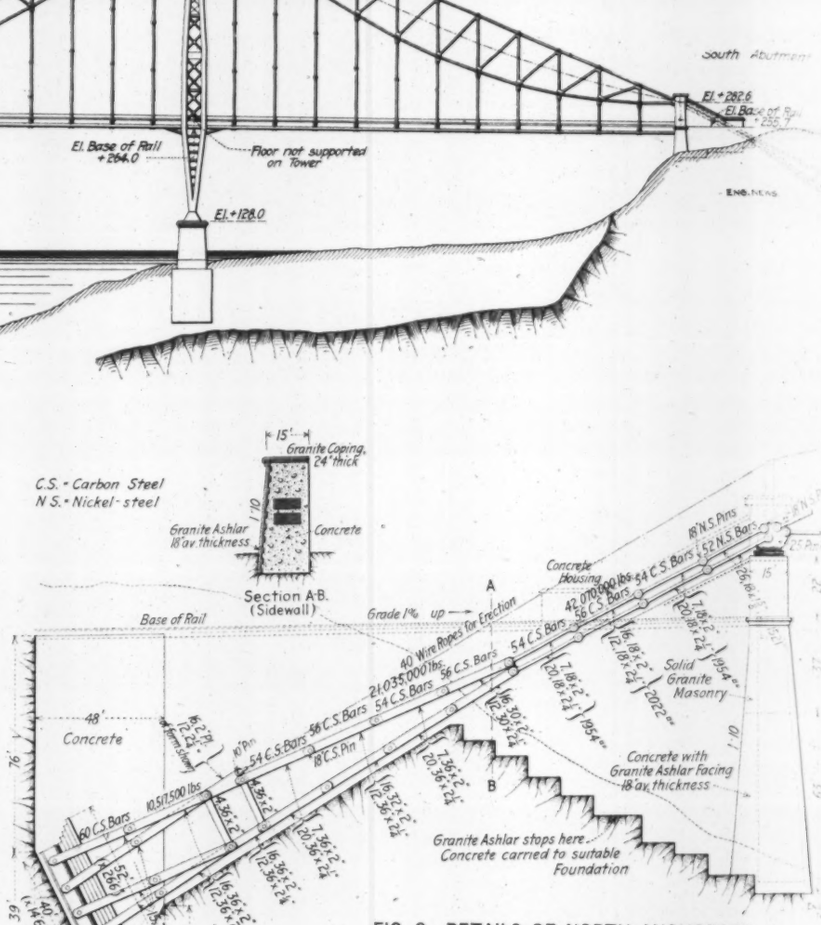
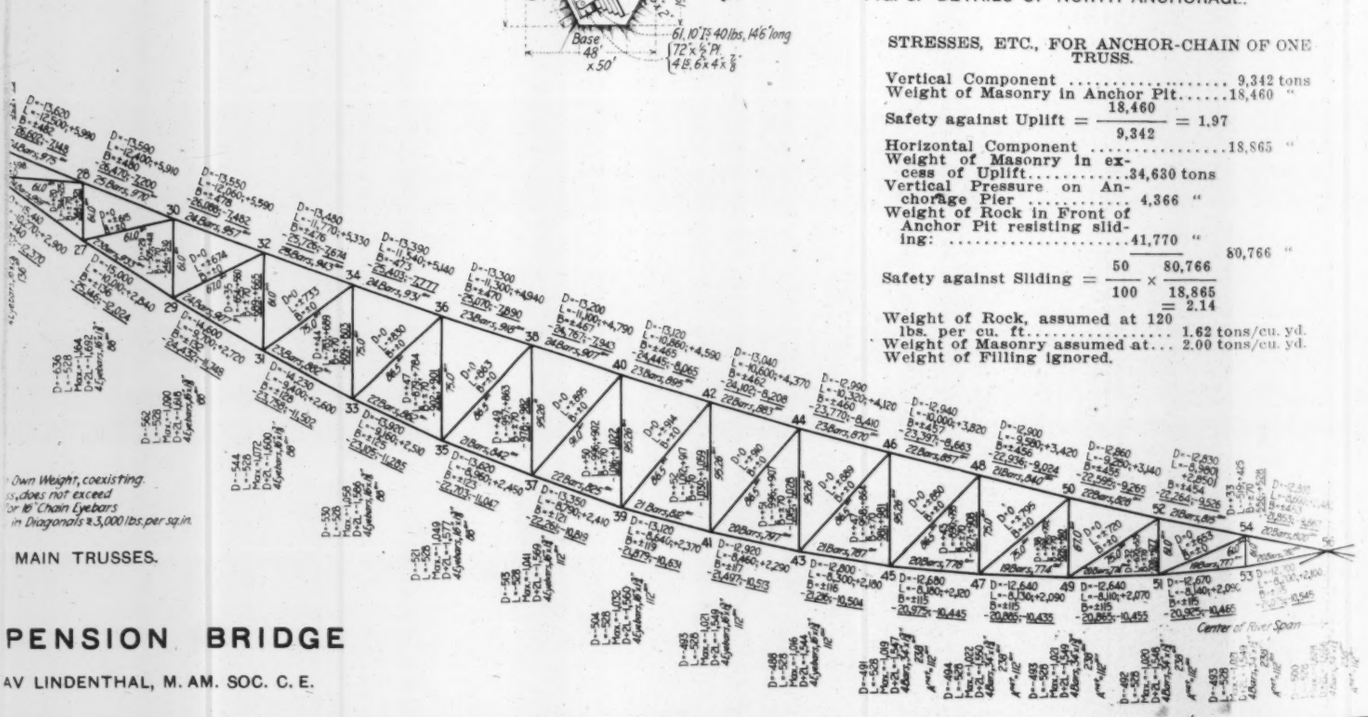


FIG. 8. DETAILS OF NORTH ANCHORAGE.



MAIN TRUSSES.

STRESSES, ETC., FOR ANCHOR-CHAIN OF ONE TRUSS.

Vertical Component ..... 9,342 tons
Weight of Masonry in Anchor Pit..... 18,460 "

$$\text{Safety against Uplift} = \frac{18{,}460}{9{,}342} = 1.97$$

Horizontal Component ..... 18,865 "
Weight of Masonry in excess of Uplift..... 34,630 tons
Vertical Pressure on Anchorage Pier ..... 4,366 "
Weight of Rock in Front of Anchor Pit resisting sliding: ..... 41,770 "
80,766 "

$$\text{Safety against Sliding} = \frac{50}{100} \times \frac{80{,}766}{18{,}865} = 2.14$$

Weight of Rock, assumed at 120 lbs. per cu. ft..... 1.62 tons/cu. yd.
Weight of Masonry assumed at... 2.00 tons/cu. yd.
Weight of Filling ignored.

PENSION BRIDGE

AV LINDENTHAL, M. AM. SOC. C. E.

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The Eye-Bar Suspension Bridge for Long Spans.

Conventional types of bridge construction seem to exercise a sort of tyranny over the minds of most bridge designers. Scant attention is paid by the average American engineer, we fear, to designs which are not "standard practice."

This system has its advantages, of course, in economy of manufacture; but there may be serious loss in carrying it too far. The American engineer who goes abroad and studies the work of European engineers finds a much greater variety in design, and even a premium placed on originality, when it contributes to excellence or to economy.

We believe bridge engineers generally will find it a good tonic to study the eye-bar suspension bridge design for the Quebec Bridge competition contributed by Mr. Gustav Lindenthal to this issue. Doubtless most American bridge engineers have cataloged the eye-bar suspension type of structure in their mind as merely an obsolete curiosity. Mr. Lindenthal's discussion indicates that the development of high-strength alloy steels have made the type well worth the engineer's consideration under certain circumstances.

Probably those who have studied the eye-bar bridge type in recent years have felt that a great drawback was the difficulty of erection. The most prominent example, the Budapest bridge, was erected on falsework, and if this is necessary one chief advantage of the suspension type disappears.

In Mr. Lindenthal's Quebec Bridge design, however, a plan is worked out for erection without falsework, building up the eye-bar cables piecemeal, as a wire cable for a bridge it built up. The successful accomplishment of this places the eye-bar bridge on an entirely different footing.

It is an easy habit to classify all ordinary crossings by length and establish a few dividing lines to separate lengths appropriate to one standard type from those suited to another standard type. This practice leaves out of account the fact that such matters as topography, foundation conditions and loadings, to say nothing of artistic demands, ought to be considered in fixing the type of bridge to be chosen for a given location.

For the St. Lawrence River crossing at Quebec, the cantilever type has received almost exclusive consideration, from the very first, to the neglect of the suspension and arch types. The reasons were probably in the main commercial, or let us say industrial. At no stage can the Quebec design be said to have been treated as purely an engineering problem for which the best solution was to be sought regardless of all other considerations.

That the suspension bridge is a strong competitor in long-span work is well enough known. Considering that the eye-bar design relies on approved structural elements assembled in approved fashion, and that it may therefore be regarded as a design for which full precedent exists, one may readily understand Mr. Lindenthal's choosing it for the Quebec Bridge competition. But the type deserves much broader consideration than for the longest spans alone. It ought to be considered as an inverted arch frame. All the rigidity and economy of the arch frame appertains in the same measure to the rigid suspension frame, allowing only for the substitution of anchorages for thrust abutments and the addition of towers. It is to be noted that the braced arch finds frequent application in medium-span crossings—Mr. C. A. P. Turner's five-arch bridge over the St. Croix River is a very recent instance. By the same token the rigid suspension frame, the inverted arch, has a claim to consideration in medium-span bridge work. There are reasons for expecting that this claim will find better recognition in future.

Freight Rates on "Knocked Down" Altars.

Those of our readers familiar with the historical books of the Old Testament will recall what a figure the tribal altars played in the wars of that period. When the Israelites conquered a heathen tribe, it is particularly recorded that they knocked down its altars; and their own altars met a similar fate whenever the heathen got the upper hand.

One is curiously reminded of these ancient customs by reading a recent decision of the Interstate Commerce Commission, in a case in which the plaintiff "made prayer for reparation" because he had been charged as high a freight rate on a "knocked-down" altar as on an altar set up. Quoting from the Commission's decision:

> Complainant does not object to the rating of altars, set up, at double first class, but contends that altars knocked down, ought not to be rated higher than first class.

It appears that the men who made the "Western freight classification" fixed the same rate on knocked-down altars and altars set up. The tribes who inhabited Palestine three thousand years ago knew better than that. Evidently the Interstate Commerce Commissioners are more versed in Biblical knowledge than the unregenerate traffic experts responsible for the Western classification, for the complainant's prayer was granted.

A Reform in the Railway Mechanical Conventions.

An announcement of some importance has been made in connection with the annual conventions of the Master Car Builders and Railway Mechanics' Associations. By agreement between the officers of these associations and the officers of the Supply Men's organization, the lavish entertainments which have for years been a feature of these conventions will this year be abolished.

We believe every self-respecting railway mechanical officer will welcome this announcement. It is true that some of the principal abuses in connection with the entertainment functions which were carried on twenty years ago were abolished when the entertainment at these annual conventions was made a joint affair of all the supply firms interested. It came to be realized at length, however, that what was wrong with the entertainment was not the particular way in which it was done, but the fact that free entertainment was furnished at all.

The firms dealing in railway supplies ought to get business from their customers on the merit of the goods they manufacture. It is, or ought to be, absurd to suppose that the mechanical officer of a railway company is going to place an order for car wheels, brake shoes or shop machinery perhaps amounting to $100,000 with one firm instead of another simply because he was royally entertained by one firm for three days or a week at Atlantic City in June.

When the original reform was made, many years ago, of putting all the entertainment money in a common fund, the real object of carrying on the entertainment was practically nullified. So long as the supply men held to their agreement and gave all the members of the association the privileges and perquisites which were provided by general subscription, the only practical effect of the entertainment was to make the railway officers as a class consider the supply men as their hosts. It has been clearly recognized, however, by the ablest men in the railway service that the whole idea of having the railway mechanical officers accept hospitalities from the supply men was undignified and ought to be done away with.

Winter Journeys to See the Panama Canal Work.

The Panama Canal will be visited by a larger number of engineers this winter probably than at any previous time. A round-trip rate of $100 from New York to Colon and return on the Panama R. R. steamships has been put in force, to continue until March 31. The other steamer lines running to the Isthmus also offer attractive excursion rates in connection with tours of the West Indies. The canal work is now at its most interesting stage, as all classes of construction are in progress. By next spring, however, the amount of excavation going on in Culebra Cut will be very considerably reduced. The American Institute of Electrical Engineers is to conduct an excursion to the canal for its members, sailing from New York about the end of January.

The pleasure of an ocean voyage to the Tropics during the winter season, with the opportunity to visit the canal work and the low rates offered for an ocean journey of nearly four thousand miles, should induce many engineers to take the Panama trip during the next four months.

Beware of Stock in Potash Mines.

Newspaper publicity regarding the scarcity of potash and the present reliance of the world on Germany, which has the only known mineral deposits of potash, is being turned to advantage by shrewd promoters who are advertising stock in mining concerns which are said to own deposits of "potash ore." The U. S. Geological Survey calls attention to the fact that while feldspar is known to contain a considerable percentage of potash, there is no known method of separating the potash from the rock on a commercial scale. The proposition to buy feldspar, or feldspar granite deposits, on the strength of the potash they contain is just as sound as it would be to value a deposit of ordinary clay by its contents of aluminum.

The Need of Engineering Reference Libraries.

A most interesting and important benefaction has been undertaken by Mr. E. L. Corthell. He has given his extensive engineering library, containing some ten thousand volumes, to Brown University, at Providence, R. I. The University has accepted the gift and provided accommodation for the library in the John Hay Library Building, erected at that institution as a memorial to the late Secretary of State. Mr. Corthell was a graduate of Brown University

in the Class of 1867, and Secretary Hay graduated a few years earlier.

The value and interest of Mr. Corthell's gift is not merely in the number of volumes which his library contains, but in the fact that the collection is a working library. Mr. Corthell has not only been a generous contributor to the literature of his profession, but he has systematically collected such literature in a manner that few practising engineers have attempted. For one thing, Mr. Corthell holds membership in a larger number of engineering societies, American and foreign, probably than any other engineer in this country. The total number is 24; and of practically all the societies and institutions of which he is a member, he has in his library the published transactions or proceedings, bound in permanent form, the file in many cases extending back to the origin of the society.

The entire library, which Mr. Corthell has kept at his permanent American residence in North Egremont, Mass., is card cataloged. Further, Mr. Corthell has arranged with the various societies in which he holds membership to have the sending of their publications continued in perpetuity to the Corthell library, at Providence. To provide for any necessary expenses in connection with this or other maintenance of the library he has provided an endowment of $5,000. Besides the Society transactions referred to, the library contains bound volumes of the principal engineering periodicals extending back for many years, and subscriptions to these also Mr. Corthell has arranged to have continued.

We give prominence to this excellent disposition of an important collection of engineering literature because it may furnish a fruitful hint to other prominent engineers as to the wise disposition of their engineering libraries when they retire from professional practice.

Mr. Corthell's gift also makes worth while some discussion on the importance of reference libraries to an engineer at the present day. There is, in fact, no more important or necessary tool to the practising engineer of to-day than a first-class reference library.

It goes without saying that an engineer will attempt to possess and to carry with him where he goes a fair sized collection of the standard reference books bearing on the particular line of work in which he is engaged. We are not now referring to such reference libraries, but to the general library, containing what may be characterized as the accumulated fund of knowledge of the profession; a library of such magnitude as no engineer or engineering firm can afford to possess or to maintain, but which is, nevertheless, as we have said, a necessary tool to many engineers at the present day.

It is worth emphasizing that the necessity of reference libraries to the engineer is a comparatively recent requirement, resulting from the enormous development and specialization of engineering work in many fields and of the corresponding development in technical literature.

It is easily within the memory of engineers still in active practice when pretty much all the really valuable and reliable books relating to civil engineering work, at least, could be carried around by an engineer in his trunk and still leave plenty of room for necessary clothing. As for other fields of engineering, they were hardly existent at that time, and literature concerning them was likewise lacking. Contrast with this the situation at the present day, when the library of an individual engineer like Mr. Corthell may contain upwards of ten thousand volumes, and when the really great engineering reference libraries contain several times this number.

The national engineering societies have indeed made a good start in the provision of national reference libraries for engineers. The collection of the American Society of Civil Engineers, housed in the Society's building at 220 West 57th St., New York City, and the joint library of the national societies of Mechanical, Mining and Electrical Engineers, housed in the Engineering Societies' Building at 29 West 39th St., New York City, are probably the best working libraries for engineers' use in the United States. In order to make both of these libraries available to engineers residing in all parts of the country, provision has been made whereby searches in these libraries are undertaken by the library staff for any engineer willing to pay the cost of the time spent in the work.

Excellent though these libraries are, and excellent though the plan is for extending their usefulness to engineers residing in distant parts of the country, they are only the beginning of what ought to be created to furnish engineers with means for accomplishing their work in the best way. An engineer can gain vastly more, both in knowledge and inspiration, by going himself into a reference library and consulting books at first hand, than he can from any report of a search by the library staff. Every engineer in the United States ought to be able to reach a good engineering reference library at least without traveling beyond the borders of his own state. There ought, therefore, to be a good engineering reference library, open to the use of any engineer, at every state capitol city and in every good-sized city in the country.

If any criticism at all were to be made of Mr. Corthell's gift, it would be that such a library as he has collected is needed a thousand times more for use by practising engineers than it is by the teachers and students of an engineering school.

Without doubt, however, the Corthell library at Providence will be freely open for use by any and all engineers who choose to take advantage of it. The same thing is, or ought to be, true of the engineering library of every engineering school. It happens quite frequently that these schools have become the custodians of what is often the best collection of engineering books available in a given locality. Undergraduate students, however, have their time so fully occupied by their regular studies that they can make comparatively little use of the collection of volumes in the library. Besides this, most of the books are for the use of practising engineers, not of undergraduate students. The most that can be expected of the students is that they will learn while in college how to use the library to the best advantage. Its real value to them will be as a resort for information when they enter upon the active practice of their profession. It may be said, of course, that the graduates from Brown University will be scattered far and wide in different parts of the country, but this only emphasizes the need for the distribution of reference libraries in all sections of the United States.

Engineers as a class seldom have opportunity to live in one locality during all their years of active work. Change of position and occupation from one part of the country to the other is the general rule. Therefore the need for engineering reference libraries in all parts of the country is one which concerns the profession as a whole.

It is worth particular emphasis also that if such engineering reference libraries as are here suggested are to reach their highest usefulness to the profession, they must be conducted under engineering direction. The average custodian of a public library is just as little competent to form and manage a working library for engineers as he would be to carry on a working library for physicians or for lawyers. Go into almost any public library and examine critically its collection of engineering books, and it will be found that a considerable proportion are either out of date works with only historical value or are cheap books of a pseudo-scientific order, too unreliable to be taken as a guide by the working engineer.

Two essentials to the usefulness of an engineering library are, first, proper classification and, second, thorough indexing. To accomplish each of these engineering knowledge is essential. A small collection of books, thoroughly indexed and well classified, is far more useful than a huge collection arranged in hit-or-miss fashion and with no better index than the ordinary library staff can prepare.

The value of bound volumes of Society transactions and engineering periodicals is dependent almost entirely upon the completeness with which their contents have been made available by careful indexing. We feel perfect liberty to say that this is the reason every public library which aspires to useful to the engineering profession should contain the bound volumes of Engineering News, including back for at least ten to twenty years. These volumes, as our readers know, have been made easy of reference by the publication at intervals of book indexes containing in a volume all the references to articles published during a five-year period.

We need not emphasize further to engineers the necessity for such widely distributed engineering reference libraries as are here proposed; but a word may be said as to how they might be created. We believe that if the engineering societies throughout the country were to take the matter up, provision could readily be secured, in cooperation with established public libraries and with the libraries of engineering schools, for the equipment and maintenance of a first-class working library in every city of large size. The close connection of such libraries with the subject of efficiency in municipal administrative and public work generally should commend it to favorable public attention, and should make it possible to secure state appropriations to establish and maintain such libraries in every state capitol city where they are not already in existence.

If the engineering societies of states and cities made themselves prominent in such a movement, they might naturally be given authority to nominate trustees for such special libraries. In that way they would be able to direct the conduct of such libraries so that they might be made of greatest usefulness to the working engineer.

LETTERS TO THE EDITOR.

Can Man Achieve Soaring Flight?

Sir: The writer's attention was attracted by an editorial in your issue of Nov. 2, in which the resistance of aeroplanes was discussed, and contrasted with that of other vehicles.

The figures quoted were indeed interesting, but in the discussion of the future of the aeroplane, it hardly seems proper to ignore the fact that in the gliding flight of birds—not one but many species—this resistance is actually negative. The buzzard is perhaps the most familiar example of perfect gliding flight, which is accomplished practically without the expenditure of energy, once that altitude is attained.

Actual experimentation along these lines is not new. That pioneer and martyr of aviation, Otto Lilienthal, has recorded the fact that with his little glider he at times, poised on the crest of the hill, allowed the wind to raise him from the ground, and still rising, went forward against the wind. The recent press dispatches seem to show that the Wright Brothers have been still more successful—in fact, they seem on the verge of an actual solution of the problem of maintenance and volition in the air without the expenditure of energy.

The fact that the larger birds can travel up or down at will without moving their wings except for the direction of flight and maintenance of equilibrium, demonstrates that there is nothing physically impossible about this problem. The partial success of experimenters is further encouragement to the hope that eventually means will be developed by which flight may be accomplished by man with no more expenditure of power than that necessary to rise to the proper altitude. And indeed, the reports from the recent work of the Wrights would seem to indicate that under proper conditions it will be possible to rise from the ground with no other power than that of the wind.

Geo. S. Binckley, M. Am. Soc. C. E.

Room 1000 Union Trust Bldg., Los Angeles, Nov. 9, 1911.

[Our correspondent will pardon us for sounding a note of skepticism. The soaring birds have an enormous spread of wing compared with the weight of their bodies. Many students of soaring flight believe that these birds take advantage of slight upward currents in the air, the existence of which over all land of irregular contour is made evident by the erratic course of floating thistle-down or bits of tissue paper. It

is probable t[illegible] to utilize the energy of these gentle upwar[illegible]currents for soaring flight, some such relation[illegible]etween wing spread and weight must be reta[illegible]d as nature has adopted in the eagle and th[illegible]vulture. It is noteworthy that even among [illegible]he birds, very few have wing spread enou[illegible] in proportion to weight to attempt sustai[illegible] soaring. When they attempt it they slide do[illegible]hill on the air like an aeroplane. —Ed.]

Water Use and Water Waste.

Sir: In Engineering News of June 8, 1911, you say: "The object of water meters in not to curtail use but to reduce waste of water."

While this is admirable, I submit that it tells only half the truth, that the other and more important half is the one which might appeal to a public not yet instructed by experience, in the benefit of the water meter, and that your statement should be amended to read: "The object of water meters is not to curtail but to increase the use of water"; for, with a given supply, restriction of waste not only increases the quantity remaining available for use, but (by increasing the pressures throughout the distribution system), increases also the utilization of this increased quantity.

This was stated in your issue of June 29, 1911, page 789, where you say: "The water meter actually contributes to good sanitation by insuring a supply of water for everybody."

The man on the street, like the Mayor of New York, regards the water meter as a device by which the municipality (or its agent, the water company) seeks to cover its own short-comings by giving him less water for the same money.

So long as he remains under this delusion, he is to be commended for objecting to the meter. You have very properly contradicted this impression, assuring him that the meter seeks to prevent only waste; but in this he is only languidly interested. Waste restriction is a public matter; and, like the man with the muck rake, he concentrates upon his own private and exclusive wealth ("the straws, the small sticks and dust of the floor"), regardless of the real wealth which comes to him by virtue of his membership in "the public."

But once let him see that the meter, so far from restricting his use of water, actually increases it (and that without increasing his bills), and you will have converted him from an enemy to an ally.

The effect of the meter, in increasing the use of water, is illustrated by Figs. 1 and 2 in the enclosed circular, which I sent to the members of our civic legislature in March, 1906, just as their honorable bodies (in obedience to their "political" owners) were showing their animosity to Major Cassius E. Gillette (then in charge of the construction of the city's filter plants) by vowing eternal enmity to his very sensible proposition to meter our unhappy town.

As you will see, these two figures are not mere fancy sketches, but represent actual conditions.

In your issue of June 1, 1911, replying to Mr. Winslow H. Herschel, you say:

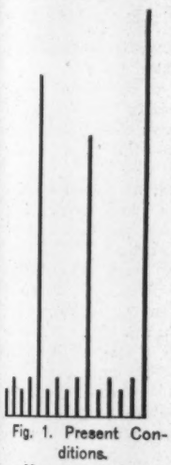


Fig. 1. Present Conditions.

More than half the water pumped is wasted by less than one-fifth of the people.

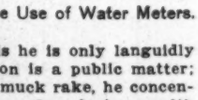


Fig. 2. With Meter.

Reduction of bills and increased pressure encourage liberal use of water.

The three tall lines, in Fig. 1, represent, by scale, the water consumptions of the few persons who, by wasting more than we use, deprive us of the full supply we pay for.

In both figures, the short lines represent the water consumptions of the non-wasters, who are in a majority of at least four to one, but who allow the minority to rob them.

In Fig. 2, these short lines are longer than in Fig. 1, because the water, at present wasted by the few, has been saved, by the meter, and given to the many.

All this is based upon actual tests, often repeated.

A Graphical Argument for the Use of Water Meters.

It is one thing to measure water to a private house occupied by a small family who live frugally. It is quite another thing to measure the water delivered to a tenement or apartment house where the man or woman who uses water does not care a copper how much the landlord has to pay for it. And speaking broadly, every resident of New York City either lives in a rented apartment or else is so wealthy that he cares very little how much he wastes of water or anything else.

As to the wealthy, my impression is that the same characteristics, which make and keep them wealthy, generally render them averse to spending even small portions of their wealth in directions which bring to them no tangible return in comfort, luxury, display or "pleasure"; and that, while they will use (and pay for) water lavishly, they will repair the leak and "fire" the careless servant, to keep the meter bill down.

As to the apartment house or tenement, your argument evidently assumes that the occupants of apartments are not to be separately metered; but, in your issue of June 8, 1911, you quote Mr. Clemens Herschel as saying, in reply to this very objection, that "the cure is a simple and a homeopathic one; it is to put in more meters, until each one's waste is brought home to him."

It should cost less to meter a hundred families, living in apartments, than to meter the same hundred families living in separate houses. The apartment house argument therefore falls to the ground.

Nevertheless, I reluctantly agree with you and with Mr. Freeman that even universal metering, in either New York or Philadelphia, would fail to bring the consumption down to the reasonable allowance of 40 gals. per capita per day, but I also heartily concur in the position which you have always maintained, that universal metering would well repay its cost, especially here in Philadelphia, where the per capita consumption (after making all proper allowance for slip of pumps and other exaggerations) is probably more than double that in New York (although apartment houses and wealthy people are still the exception here), and where we still have to put up with a mixed supply (raw water mixed with filtered water), notwithstanding the expenditure of some $30,000,000, years ago, for plants capable of supplying an abundance of filtered water to three times our population.

The following, from the Philadelphia "Public Ledger" of Oct. 31, is pertinent to the subject of the last part of the immediately-preceding sentence:

> A further extension of the city's filtration plant is contemplated by the Bureau of Water. Inasmuch as the Belmont plant is now being operated at its full capacity of 43,000,000 gals. daily, Chief Dunlap, in a report to Director Mackey, yesterday recommended that extensions and additions be made to the preliminary filter beds at this plant, at an estimated cost of $600,000.
>
> By this means Mr. Dunlap said the capacity of the plant would be increased to 60,000,000 gals. daily, which he declared would be needed next year, or West Philadelphia would run short of water, as the present supply would not meet the demands.

As a minor matter, I venture to criticize your use of the expression (June 8, 1911, page 698), "total consumption (and waste)." In the interest of clearness of definition, let us adopt the simple and rational formula:

$$\text{Consumption} = \text{use} + \text{waste}.$$

John C. Trautwine, Jr.

257 South Fourth St., Philadelphia, Nov. 2, 1911.

Some Light on the Collision of the "Olympic" and the "Hawke."

The collision of the steamship "Olympic" with the British cruiser "Hawke," which was described briefly in our issue of Oct. 19, p. 463, has been investigated by the British Naval Court of Inquiry. While the findings of this court are not given out officially to the press, some news of the decision has been published purporting to come from a high official in the British Admiralty. According to this report, the commander of the "Hawke" has been completely exonerated from any blame for the accident on the ground that the "Olympic," as the overtaking vessel, should have kept clear of the cruiser. It is claimed that the "Olympic," without giving any warning signals, passed so close to the "Hawke" that the cruiser's bow was drawn against the liner.

The relative reactions of vessels under way and close to one another were discussed by Naval Constructor D. W. Taylor, U. S. N., in a paper read before the Society of Naval Architects, and Marine Engineers in June, 1909, entitled "Some Model Experiments on Suction of Vessels." An extract from Mr. Taylor's paper follows:

> When the overtaking vessel just begins to overlap the other, there is little force acting. There appears to be a repulsion at both bow and stern, and curiously enough the repelling force upon the stern appears to be greater than that upon the bow. The resulting tendency is for the overtaking vessel to turn in toward the overtaken vessel. When partially overlapping, the tendency is for the bow to be drawn in while the stern is still repelled.
>
> As the overtaking vessel continues to pull up, the suction at the bow becomes stronger and the repulsion of the stern falls off, until, as they come abreast, there is a rapid change in the stern force, which shifts from repulsion to strong suction.
>
> As the overtaking vessel draws ahead, there is a reversal of conditions, the bow pull falling off rapidly and soon becoming a repulsion, while the stern pull becomes stronger, reaching its maximum when the center of the overtaking vessel is about two-tenths its length ahead the center of the overtaken vessel.

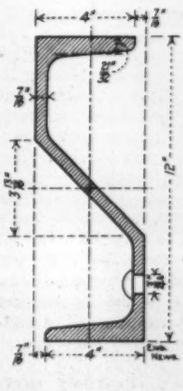
These conclusions were based upon a series of tests made in the model basin at Washington, D. C., upon four models of 3,000 lbs. displacement each with a common length of about 20 ft. and about 3½-ft. beam. During the tests, the models were towed in pairs abreast one another or at definite distances ahead or astern at speeds of from two to three knots. The models were not allowed to yield to the forces set up, being compelled to remain parallel to one another. The pulls or repulsions were measured at two points, near the bow and near the stern. It was found that the forces acting for a given relative location of the models varied with speed as the resistance of the model.

Mr. Taylor comments as follows upon the difficulty of avoiding a collision after certain positions are reached:

> Consider the position where the overtaking vessel [On the right.—Ed.] is four-tenths its length astern. There is here a strong tendency to swing the bow in toward the other vessel and cant the stern out. If the rudder is put to starboard with the idea of throwing the bow out, the result will be either a diminution of the force at the stern which is pulling the stern to starboard, or its reversal, there being substituted for it a force which will push the stern to port. If the force is not reversed, there will still be the tendency to swing the bow closer to the overtaken vessel. If the repulsive force is more than balanced, we shall have forces both at bow and stern pulling the vessel bodily to port, and probably this will be sufficiently great to bring the vessels together regardless of the rudder action.
>
> It appears then that when one vessel has once begun to pass another at too small a distance for the speed, a collision becomes almost unavoidable. Thus the blame for such a collision would indeed lie with the man in charge of the overtaking ship.

A Rolled S-Section.

A rolled section of S-shape has been introduced in Russia, being rolled by the Putiloff Works of St. Petersburg under patent. Its proportions of height and breadth are similar to those of channel sections, but the flanges face in opposite directions and the middle part of the web has an inclination of 45° to the axes of the section. The point of each flange is set somewhat back of the back face of the web at the other flange, leaving this latter face available for rivet attachments. The section thus permits rivet attachments on four sides. It is rolled in sizes from 5½ ins. deep by 2½ ins. flange width to 12 × 4 ins. The cut herewith shows the largest size. ("Stahl u. Eisen," Oct. 12, 1911.)



Annual Meeting of the National Municipal League.

The seventeenth annual meeting of the National Municipal League was held at Richmond, Va., Nov. 13-16. A wide range of municipal topics was discussed, including city government by commission, special phases of taxation, municipal finances, public health and electoral reform.

The Executive Committee announced that the next meeting will be held at Los Angeles, Cal., in July, 1912. The committee also stated that the League would begin the publication of a quarterly, entitled "The National Municipal Review," in January, 1912, and that a Municipal Year Book was under consideration jointly with the Special Libraries Association and other associations concerned with libraries.

The election of officers resulted in the re-election of Mr. William Dudley Foulke, of Richmond, Ind., as President; Mr. Clinton Rogers Woodruff, of Philadelphia, as Secretary; and Mr. George Burnham, of Philadelphia, as Treasurer.

THE MUNICIPALITY OF FRANKFORT, GERMANY.—The presidential address was devoted to an interesting review of the government and manifold activities of the city of Frankfort, Germany. The information given in the address was based upon a first-hand study made during the past summer. Municipal ownership prevails to a marked extent in Frankfort, and includes even forests and opera houses. The city also operates pawn shops and conducts funerals for those needing to avoid the high expense often incident to these services when under private control. The discussion of the unearned increment, employment for workingmen in particularly dull times, and workingmen's insurance and other features of the municipal government of Frankfort were dwelt upon interestingly by Mr. Foulke.

ANNUAL REVIEW.—Mr. Clinton Rogers Woodruff, Secretary of the League, stated in his annual review for the current year that the two great recent tendencies in municipal affairs had been the expansion of municipal functions and the adoption of the commission plan of government. As illustrating another important new factor in certain phases of municipal affairs, mention was made of the fact that 27 states and 14 cities are now provided with public utilities commissions.

The recall has recently been declared constitutional by the State Supreme Court of Texas. The constitutionality of the initiative and referendum is now before the highest court of the land, having been argued early in the present month before the United Supreme Court in the so-called Oregon cases.

Socialist candidates were recently successful in the elections of 75 cities. The notable shortcoming of the Socialists, Mr. Woodruff stated, has been the class spirit which they have shown. This leads to divided instead of united civic action, and is unfortunate at a time when party and class distinctions are being broken down.

Finally, Mr. Woodruff stated that the most notable feature of municipal life to-day is an increased spirit of hopefulness.

THE THRALDOM OF MASSACHUSETTS CITIES.—That the towns of Massachusetts in most respects, and the cities in all respects, are helpless infants under the control of the Legislature was forcibly brought out by Mr. Harvey N. Shepard, of Boston, in a paper, every statement of which, the speaker said, was based on decisions in the Massachusetts Supreme Court. Mr. Shepard was strongly of the opinion that two things are necessary for the future success of Massachusetts cities: That each city be entirely freed from legislative control, except in those requirements which are made applicable to all cities of the state, and that the cities in general be given power to do all things necessary to be done without having to go to the Legislature before taking up each new enterprise or extending enterprises already authorized and undertaken.

REPORT OF COMMITTEE ON CITY GOVERNMENT BY COMMISSION.—Mr. Richard S. Childs, of New York City, Secretary of the Short Ballot Organization, presented this report, which took the form of a brief statement of things on which the committee had and had not been able to agree. He said the committee was agreed in the belief that commission government, as compared with the older forms, is a relative success. The new form is more democratic, or more sensitive to public opinion, than the older forms. This arises in large part because of unification of powers and of direct accountability of city officials to the people. The committee did not think the initiative and referendum subject to serious abuse, and did not consider the recall essential to the commission plan.

While agreeing that the commission plan may be advantageous for cities of 100,000 population and under, and possibly for those above that limit, the committee has been divided in opinion as to its advisability in cities of 500,000 and over. For these larger cities, one side believes that there should be a distinct legislative body, while the other side thinks that city government is chiefly a matter of administration, and therefore finds no objection to the concentration of legislative and administrative powers in the same body. The doubters also think the small executive body is not sufficiently representative of all parts of a large city.

In the course of the discussion on the committee report, Mr. F. S. Spence, City Controller of Toronto, Ont., was particularly emphatic in regard to the inadvisability of electing such municipal officers as the city engineer. He remarked that it was necessary to go over the whole country and search the entire engineering profession for the best man for this position, and that a city must expect to pay him a salary according to his ability and professional standing.

The discussion of this paper was continued at the so-called "Round Table Luncheon," which has been a particularly successful feature of the League's meetings for a number of years past. The discussion was opened by Rear-Admiral F. E. Chadwick, of Newport, R. I., who presented anew, but with old-time vigor, his well-known arguments in favor of what has become known as the Newport plan, as opposed to the commission plan. This plan involves as one of its main features a large representative body, which at Newport comprises 195 members. The activities of this body are rigidly confined to legislation. The speaker also renewed his strong contention for the selection of administrative officials by no other standard than those of fitness for the work to be performed.

In referring to the recent defeat of the proposed commission plan charter for Cambridge, Mass., Mr. R. H. Dana, of that city, expressed the belief that the defeat was in considerable measure due to the fact that the commission plan makes no adequate provision for the selection and retention in office of municipal experts.

EXCESS CONDEMNATION AND SPECIAL ASSESSMENTS.—A brief report on this subject was submitted in behalf of the committee of which Mr. Lawson Purdy, of New York City, is chairman. This committee has had the benefit of a paid assistant as special investigator in the person of Mr. Herbert S. Swan, of Columbia University. The committee now has in its hands a 30,000-word report from Mr. Swan reviewing the whole subject of excess condemnation. After the report has been studied, the committee will submit a further report, with recommendations.

A PLEA FOR MUNICIPAL EXPERTS.—Under the title, "Antitoxin from Municipal Waste and Corruption," Mr. R. H. Dana, of Cambridge, Mass., Chairman of the Council of the National Civil Service League, treated at some length the topic to which he adverted in the discussion on commission plan, mentioned just above. The speaker urged that those in charge of municipal policies should change often in order to reflect changes of public opinion, but that those in charge of administrative work should be experts in their various lines, and should serve for life or good behavior. The American civil service, generally, Mr. Dana remarked, is confined to relatively minor officers, and these are, as a rule, under the domination of chiefs representing political parties. As a rule, men should enter the civil service through its lower branches and gradually be promoted. When emergencies make this impossible, examining experts to choose the higher expert officials should be selected by the civil service commission to pass upon candidates.

Possible conflicts between political and expert chiefs may be reconciled largely through publicity. Expert heads of departments should be permitted to lay their case before the public, and perhaps political chiefs should be required to state their side of the case publicly.

In small cities, the Mayor might be the only political chief, and in general not more than six to eight political chiefs are needed in the municipal service, political chiefs here, of course, being used to indicate those responsible for the determination of municipal policies.

An elaboration and application of the civil service, as applied to the choice of municipal experts, might be the one thing needed to make the commission plan of city government applicable to large cities.

Mention may here be made of a lengthy address on "Municipal Civil Service Reform" by Mr. Charles J. Bonaparte, of Baltimore, formerly Attorney-General of the United States. The speaker remarked that civil service means simply the application of honesty and common sense to municipal government. Not only must unfit men not be chosen to office, but it is also equally necessary that fit candidates be selected.

ECONOMY AND EFFICIENCY IN HEALTH-ADMINISTRATIVE WORK.—A paper with this title was presented by Mr. Selskar M. Gunn, Assistant Professor of Biology and Public Health, Massachusetts Institute of Technology, Boston, who was formerly Health Officer of Orange, N. J. An agreement is needed as to what constitutes the true functions of a health department. Although progress is being made in both the definition of these functions, and the transfer of health boards to other departments, still more progress is necessary before all boards of health can settle down to their proper work. The present lack of delimitation in some cities militates against efficiency and also against securing adequate appropriations for some important lines of work. As a result, some needed work remains undone or but partly done, while other work is relatively overdone.

Efficient health-protective work demands that health administration be placed "in the hands of an individual trained in the sanitary arts." It is not sufficient that a health officer shall have "had merely the few hours of hygiene allotted to the subject in a medical school curriculum." For such small communities as cannot pay for the full-time services of a trained sanitarian, combination with neighboring communities may be effected.

Real efficiency includes economy, and this can be measured, as pointed out by the Bureau of Municipal Research of New York City, only by comparing "cost with service results." Such comparisons are often difficult, but sometimes they can be made with striking effect—as witness the reduction of typhoid fever at Richmond, shown "in the annual reports of the Health Officer, Dr. E. C. Levy, whose brilliant work has attracted the attention of all progressive sanitarians in this country."

Health-department accounts need to be put on a comparative basis, so one city can benefit from comparisons between its expenditures and those of other cities. A committee of the Massachusetts Association of Boards of Health is now formulating a standard accounting outline.

Finally, Mr. Gunn mentioned freedom "from politics, with its accompanying uncertainties and strife," and also trained sanitarians, supplied with necessary funds, as essential to the maximum of health protection at the minimum of cost.

A spirited discussion of this paper followed. Dr. E. C. Levy, Health Officer of Richmond, gave several striking illustrations of economy and efficiency, only one of which will be mentioned here. He said that the deaths from typhoid fever saved in Richmond last year by improved

sanitation had an estimated value of $350,000, or ten times the entire health board appropriation for the year.

Dr. Otto P. Geier, of Cincinnati, Ohio, urged that increased interest in public health administration might be made a great factor in awakening interest in and improving the general administration of the whole city.

Mr. M. N. Baker, President of the Board of Health of Montclair, N. J., and Chairman of the Committee on Municipal Health and Sanitation of the National Municipal League, urged that particular attention be given to three of the points made in Mr. Gunn's paper: (1) what's what in public health work; (2) the need of better training for health officers, and (3) a classification of health board expenses that would make it possible to measure the expenses in terms of work achieved, and help to show whether the work done was worth what it cost.

The general subject of public health was continued at the round table luncheon the same day, the talk after the lunch being started by Mr. John Ihlder, of the National Housing Association, New York City.

In what has been given in this article, we have only touched upon a part of the many papers and reports submitted to the meeting of the League. It is expected that a selected list of papers will be printed in the "National Municipal Review" (already mentioned) during the year, and that what remains of the Proceedings will be published as a supplement to one of the quarterly numbers of the "Review."

Annual Meeting of the Society of Marine Engineers and Naval Architects.

The eighteenth general meeting of the Society of Marine Engineers and Naval Architects was held in the Engineering Societies Building, New York City, Nov. 16 and 17. A long program of professional papers was presented and on many of the papers there was plenty of discussion to suit the most argumentative. A feature of the meeting was the visit of Sir William H. White, former Chief Constructor of the British Navy, who is Honorary Member of the Society, and the presentation to him of the John Fritz Medal for meritorious achievement. This medal was awarded by the John Fritz Medal Board, made up of representatives from the four national engineering societies of the country, at a banquet of the society on the evening of Nov. 17.

At this convention Mr. D. H. Coxe, of New York City, was elected Secretary and Treasurer vice Capt. W. J. Baxter, who resigned after a long period of service on account of ill health.

Constitutional amendments were adopted by which the terms of the 12 vice-presidents were reduced from six to three years, four being elected each year. Offices of honorary vice-president were established to be filled by men who had served as vice-president for ten years, there not being, however, more than two such honorary vice-presidents during one year. The scheme of balloting for officers was changed to permit of the presentation of an independent ticket to the members together with one drawn up by the Council. This supplants the old scheme by which the Council sent out for ballot twice as many nominations as there were offices to be filled.

The paper about which most interest centered was that of Sir William White "On the Maximum Dimensions of Ships" (reprinted in Engineering News of Nov. 16). In this paper were set forth the grounds for the author's belief that the main dimensions of the "Mauretania"—length, breadth and draft—were near the upper limit along which it would be feasible to continue. In regard to warships a return to more moderate dimensions was advocated—though not, as the author emphasized in the discussion, to small warships by any means.

In the discussion, former Rear-Admiral F. T. Bowles, President of the Fore River Shipbuilding Co., Quincy, Mass., answered Sir William White's one question—as to why the U. S. Navy had apparently abandoned the policy of building only light-draft war vessels. It was stated that in the early years of the new navy, 1880-1900, public opinion was in favor of a navy only as measure of coast defense. A light draft was accordingly required. But public opinion changed after a time and assented to a navy that could maintain the country's position as a real world power; this demanded deeper drafts. Admiral Bowles held that it required only 34% increase of displacement and 50% of cost to give 100% increase of gun power, and also that in the largest vessels there were the best safeguards during gun action.

Mr. Louis Nixon, of New York City, scouted the idea of any present limit to the size of merchant vessels, and held that harbor facilities would be provided as the larger dimensions were realized. He would find ways of designing the upper works so that the vessels could safely be driven at top speed in storm and provide for the rapid discharge of cargo.

Mr. W. J. Barney, Second Deputy Commissioner of Docks and Ferries, New York City, in the paper "Dock Facilities of New York; Present Facilities and Proposed Improvements," which was illustrated with lantern slides, showed the result of the haphazard and unplanned development of the port and how a plan was being worked out which it was hoped would be followed irrespective of changes of bureau administration, and which should finally preserve the dock facilities of Manhattan for the passenger and necessary freight services only, pushing the larger manufacturing and mere transfer stations to the shore lines of surrounding boroughs.

Messrs. F. E. Kirby and W. T. Donnelly, of New York City, in the paper "The Marine Terminal of the Grand Trunk Pacific Ry., Prince Rupert, B. C.," briefly outlined the main features of this development—a 20,000-ton floating dry dock, shore plant comprising a 1,200-KW. generating station, air compressors, machine shop, blacksmith and boiler shops, and a covered shipbuilding platform. The controlling feature was the isolated location of this terminal, 600 miles from the nearest base of supplies or place from which assistance could be summoned.

In "Cargo Transference at Steamship Terminals," Mr. H. M. Harding, of New York City, outlined in a general way how the inefficient, expensive and slow methods of loading and unloading vessels had been improved in various ports of the world by the introduction of freight-handling machinery on better designed piers.

"The Panama Canal and American Commerce," by Mr. Lewis Nixon, of New York City, was a demand that the government should take immediate steps for the encouragement of a merchant marine for the foreign trade and that American vessels should go toll-free through the Panama Canal as one way of helping to the desired end.

One of the most interesting papers was on "The Raising of the Dry Dock 'Dewey,'" by Naval Constructor L. S. Adams, U. S. N. This floating dry dock sank at Olongapo, P. I., in May, 1910, from causes unknown at the time, and its raising proved a task of extraordinary difficulty. Plans were perfected for three separate schemes (1) clearing the sinking tanks by compressed air, (2) by making watertight the compartment containing the forward centrifugal pump and working this by compressed air or steam, (3) by making the whole top and bottom decks and side walls of the machinery space, on the lower side, watertight, then clearing this of water and utilizing the "Dewey's" own pumps to raise her. The first two schemes proved futile, but the third was successful by careful manipulation. The cause of the sinking was found to lie in corroded vent pipes from the sinking tanks which left large openings to the sea; ordinarily they were above water, but at the time of accident the dock had been lowered to receive a torpedo boat and the sinking could not be controlled.

There were several papers on marine prime movers and these provoked long discussions. The first was "The Best Arrangement for Combined Reciprocating and Turbine Engines on Steamships," by Mr. G. W. Dickie, of San Francisco, Cal. His proposal was, in brief, for installations of up to 20,000 HP., one compound reciprocating engine on the center line delivering steam at 30 lbs. absolute to a steam turbine on each side. The center engine would develop 40% total power ordinarily and 60% if exhausting straight to the condenser. The chief drawback admitted was the loss of backing power in case of engine breakdown. This arrangement was not generally approved by those who commented on the paper.

"The Parsons Marine Steam Turbine and Its Application to Various Classes of Vessels" was read by Mr. E. H. B. Anderson, of New York City. This paper described and pictured the various arrangements of turbines and turbine-engine combinations which have been found advisable to meet various ship conditions. The commercial development of the Parsons marine turbine was also lightly touched upon, in contrasting the 270,000 HP. of prime movers completed up to 1906 with 6,400,000 HP. of the present (built and building). Of the latter figure, 5,300 000 HP. is in warships and 1,900,000 was ordered during the present year.

In "Heavy-Oil Engines for Marine Propulsion," Mr. G. C. Davison presented the familiar claims of the Diesel type. The paper was criticised as being too optimistic and the utility of the Diesel engine was questioned on account of the expert workmanship needed for repairs, unreliability for continuous service, inflexible speed performance, etc. A few present who had had experience in operating and designing the Diesel type frankly stated the points of trouble, claiming, however, that they were entirely details of mechanical design which could be overcome.

In the paper "Economy in the Use of Oil as Fuel for Harbor Vessels," Capt. C. A. McAllister, Engineer-in-Chief, U. S. Revenue Cutter Service, described the installation of oil-burning equipment, as auxiliary to coal, in the tug "Golden Gate" operating in San Francisco Bay. A horizontal cylindrical tank was slung under the deck beams in the fire-room space; the ordinary grate bars were left, but covered with firebrick. The tug was tied up at its pier nine-tenths of the time but with steam up ready for immediate service, so that the great fuel economy was in banking the boilers. In summer it was found that the oil could be shut off the burners in the evening and there would be steam pressure enough in the morning to start the oil pumps. The services of one fireman also were dispensed with. The annual saving was $2,749 for an investment of $2,500. It was figured that this tug, under similar service in New York harbor, where oil is more expensive, would show a saving of $1,165.

The paper "Automatic Record of Propeller Action in an Electrically Propelled Vessel," by Mr. W. L. R. Emmett, General Electric Co., Schenectady, N. Y., showed the use of recording instruments during experimental runs with the fireboat "Graeme Stewart" of the city of Chicago, to secure definite information on the conditions for satisfactory reversal.

The following papers were presented on various phases of hull design:

"Experiments of the 'Froude,'" by Prof. C. H. Peabody, Massachusetts Institute of Technology.

"Resistance of Some Types of Merchant Vessels in Shallow Water," Prof. H. C. Sadler, University of Michigan.

"Model-Basin Experiments on the Influence of Forms Upon Resistance," Naval Constructor D. W. Taylor, U. S. N.

"Ship Calculations, Derivation and Analysis of Methods," Naval Constructor T. G. Roberts, U. S. N.

"Application of Principles of Naval Architecture to Problems of Aeronautics," Naval Constructor William McEntee, U. S. N.

"Effect of Waves on a Taffrail Log," Prof. H. A. Everett, Massachusetts Institute of Technology.

The Annual Dinner, held in the grand ball room of the Waldorf-Astoria on Friday evening, was the most largely attended the Society has

ever held. Mr. Stevenson Taylor, President of the Society, acted as Toastmaster, and the first speaker was Hon. Geo. von L. Meyer, Secretary of the Navy. A notable feature of his address was his prediction that with the opening of the Panama Canal the economic waste due to the present multiplicity of navy yards would become apparent to the public and a number of yards on the Atlantic coast would be abandoned. Secretary Meyer expressed great satisfaction at the successful working of the consolidation of the former Engineer Bureau with the Line, and said it was intended that all the staff organizations of the navy (except the chaplains and surgeons, who are non-combatants under the International Red Cross rules) would become part of the Line. This consolidation does not mean that every naval officer will be an expert in every specialty of naval work from engine operation and design to hull construction and ordnance building. Different officers will have different specialties, but will all be classed with the fighting force.

The presentation of the John Fritz Medal to Sir William White was made by Mr. Onward Bates, Past-President of the American Society of Civil Engineers and Chairman of the John Fritz Medal Board of Award. Mr. Bates recalled the visit of Sir William to this country in 1904, when as President of the Institution of Civil Engineers he was at the head of the large party of English engineers who visited the United States and participated in the Engineering Congress at the St. Louis Exposition.

In receiving the medal, Sir William White remarked that his adoption of the profession of shipbuilding was from accident and not from choice, and told how he began his life's work at the age of 14, obtaining a minor position as the result of a competitive examination. At present he is devoting the greater part of his time to the work of engineering education, and he emphasized the idea that notwithstanding the specialization which has taken place in engineering, the best engineering education is a thorough training in fundamentals. All specialization should be postponed until the youth leaves school and begins work.

A most notable feature of the evening was the presence at the dinner of the venerable John Fritz, now in his ninetieth year, and still able to take the journey from his home at Bethlehem, Pa., and participate in the evening's festivities, notwithstanding the growing infirmities of age.

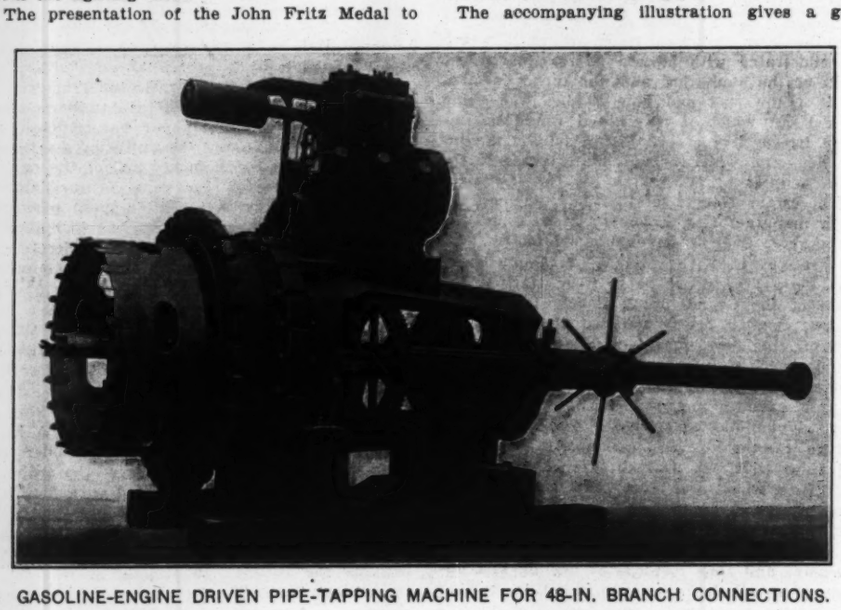
Panama Canal Excavation during October totaled 2,331,678 cu. yds., a daily average of 89,680 cu. yds. for each of the 26 working days. This is the lowest daily average for any month since December, 1907, an indication that the end of the excavating period is approaching. The rainfall during the month was 13.52 ins. During October 143,304 cu. yds. of concrete was laid and 480,455 cu. yds. of fill placed in dams.

A Pipe-Tapping Machine for Branches From 30 to 48 Ins. in Diameter.

A large pipe-tapping machine used for making a 30-in. connection with a 30-in. water main at Trenton, N. J., was described in Engineering News April 12, 1906, p. 412. The makers, the Waterworks Equipment Co., 50 Church St., New York City, expected at that time that the machine would suffice for making connections up to 48 ins. in diameter. It developed, however, that the power provided (6½ HP.) was not enough for diameters over 30 ins. and that the cutters, moreover, would hardly stand up to the work on larger diameters.

A larger and more powerful machine has since been developed by the same company. It is equipped with a gasoline engine of 15 HP. (more than twice the power of the former machine), and its cutting head has teeth made from high-speed steel. This machine, it is claimed, can be used for tapping 48-in. connections in cast-iron, lock-bar or riveted steel pipe.

The accompanying illustration gives a good idea of the machine's construction. It is 19 ft. 6 ins. in length over all and 9 ft. high, weighing 6,000 lbs. The cutting head, at the left in the photograph, is a cylindrical shell of cast steel with inserted teeth of high-speed tool steel dovetailed into slots in the forward end. At the inner end of each slot is a hole into which a wedge-shaped drift can be driven to force out the tooth when it is to be ground or replaced by a new one. Alternate teeth are given a set in opposite directions, like the teeth of a saw, to provide clearance. The form of tool used resembles a round-nosed lathe tool. Separate cutting heads have to be provided, of course, for each diameter of cut—30, 36 and 48-in.



GASOLINE-ENGINE DRIVEN PIPE-TAPPING MACHINE FOR 48-IN. BRANCH CONNECTIONS.

The cutter is revolved at a maximum speed of about 16 r. p. m. by a two-cylinder, two-cycle gasoline engine bolted to the frame of the machine. Power is transmitted from engine to cutter spindle through a train of spur gears giving a reduction of about 50 to 1. It is claimed that a 36 or 48-in. cut can be made in one hour.

The method of using the machine is the same as was described in our previous issue already referred to. A sleeve is bolted around the pipe to be tapped and a gate valve is bolted to a flanged outlet at one side of the sleeve. The tapping machine is then bolted to the other flange of the gate valve and the cutter is started. As soon as the cut is completed, the cutter is backed out and brings with it the piece of metal removed, which is held by a spring catch on the shank of the leading, or centering, drill. After closing the gate valve, the machine can be removed and the branch connection bolted on in its place. Thus the operation can be completed with the pipe under pressure.

Disinfection Experiments with Hypochlorite of Calcium on the Carnegie Swimming Pool, Yale University.[1]

By LEO F. RETTGER[2] and SAMUEL C. MARKLEY[3].

The modern swimming pool is an almost necessary adjunct to the American college or university. Its value cannot be disputed. Like most other objects of usefulness, however, it has some objectionable features. In the first place, the amount of water that the best indoor swimming pool can hold is comparatively small. Any serious contamination or infection undergoes very limited dilution; hence, it is extremely important that the greatest care be exercised in preventing persons who are suffering from diseases, especially of the skin, from using the pool. That it may be difficult to do this is evident from the fact that often a single swimming tank is used by hundreds of bathers in a single day. Under such conditions thorough inspection of the bathers is impossible.

Many cases of eye infection and even venereal diseases have been alleged to be caused by the swimming pool; but very few, if any, have been proven to be brought about in this way. The absence of proof is not sufficient guarantee, however, that diseases are not transmitted in this manner. From the standpoint of possible infection, as well as from the esthetic, some satisfactory method of purifying the water of the pool should be employed. This view is being accepted gradually by those who are in charge of the larger swimming pools.

Letters of inquiry sent to most of our large universities and technical schools brought out the fact that in the large majority of the institutions heard from no effort was made to disinfect or in other ways purify the water in their swimming tanks. In several instances we were informed that the matter of purification was receiving serious consideration. In one case the water was filtered at regular intervals and returned to the pools. At two of the universities experiments had been conducted in which chloride of lime was used. The eagerness with which a number of the institutions sought a practical and efficient method of safeguarding their swimming pool led us to believe that the subject under discussion was considered by them to be of considerable importance.

Two methods of chemical disinfection of water-supplies have received much attention in recent years, namely, the copper sulphate and the chloride of lime treatment. Copper sulphate has fallen into disrepute, while chloride of lime is heralded by many as a most satisfactory agent in the purification of water-supplies. There seems to be very little doubt now of the efficacy of bleaching powder. The common bacteria of the intestinal tract, as well as the bacillus of typhoid fever, Asiatic cholera, and in fact almost all bacteria, are destroyed by chloride of lime in a very short time, and when the agent is present in very great dilution. A few species of bacteria have been found to offer considerable resistance, but they are of little importance in this connection. The value of the treatment of drinking water with chloride of lime has been fully demonstrated in Jersey City during the past year. It was shown that excellent purification of water could be secured with bleaching powder, at a practically nominal cost.

Chlorine in the above form is now used in many cities, in conjunction with filters, and without them. It is employed at Poughkeepsie, N. Y., and at Indianapolis, in connection with slow sand filters; and at Little Falls, N. J., Harrisburg, Pa., and many other places in connection with mechanical filters, where the bleaching powder process not only introduces an added safety to the water, but also lessens considerably the cost of operation. The bleaching powder process marks a great advance in water-works

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practice. It must be intelligently applied, however.

The "bleach" process has been used also in the treatment of swimming pools, and apparently with gratifying results. At Purdue University[1] the chloride of lime was thrown over the surface of the water, after which bacteriological examinations of the water were made at certain intervals. Although the experiments were few some interesting data were furnished, the treatment in one or two instances bringing about an almost sterile condition of the water. The amount of chloride of lime employed was 20 lbs. to 1,000,000 gals. of water. In a recent publication from Brown University[2] Bunker states that by applying the agent in dilutions of one part of available chlorine to two million parts of water the water was rendered sterile in one hour.

During the past year we undertook a similar investigation in connection with the Carnegie Pool in the Yale University Gymnasium.[3] This investigation extended over a period of several months. It was begun in the early part of November, 1910. The pool is located in a substantial building of appropriate design. The pool itself is a rectangular concrete tank lined with white tile, and is 75 ft. long, 30 ft. wide and from 7 to 10.5 ft. deep, the bottom sloping lengthwise. The capacity of the pool is 150,000 gals. Water at an average temperature of 72° F. enters at the shallower end 5 ft. below the surface, and overflows into gutters which run the full length of the pool on both sides. These gutters are about 3 ins. below the walk-ways surrounding the pool, and serve as a hand rail for the swimmers. The walk-ways are constructed in such a manner that all the water falling upon them drains away from the pool into a gutter provided for that purpose.

Swimmers before entering the pool are subjected to a brief examination by the superintendent, and are required to take a shower bath with soap. No clothing besides short trunks is permitted, material of dark texture being rejected. The pool is used daily by from 300 to 400 men, at least during the greater part of the year.

The water which enters the tank is obtained from 30 driven wells which are located back of the gymnasium. These wells are driven to a depth of from 18 to 20 ft., in comparatively loose sand to an underlying bed of hardpan. They are in an open piece of ground which is used for certain athletic sports. This area is surrounded, at some distance, by buildings which are used for store rooms, lunch rooms and dwellings. As far as is known, all closets in this vicinity are connected with the sewer.

Bacteriological examinations of the well water were made on several occasions. Colon bacilli were not found in amounts varying from 1 to 5 c. c. From 200 to 500 colonies of bacteria per c. c. were obtained on lactose-litmus-agar plates, none of these colonies being of the acid-producing type. By the gelatin plate method there was a bacterial count of 1,300 on two different occasions. The tests for the presence of the colon bacillus were made in large duplicate series. No objection could be made to the use of this water for bathing purposes, at least with respect to sewage contamination. The thick layer of sand through which the water must pass from the surface of the ground downward purifies it of any pollution which it might receive on the surface.

The water is drawn from the wells by means of a pump which is located in the basement of the gymnasium; it is heated by exhaust steam, and then admitted to the pool at the rate of 12,000 gals. in 9 hours. After entering the pool the water is very clear; at times a sediment, which upon examination was found to be made up of fine particles of red sand, together with hair, epithelial tissue and other refuse matter from the bodies of the bathers, was observed at the bottom of the pool. After the pool had been used by a large number of swimmers appreciable amounts of bacteria of varying descriptions could be detected easily in the sediment by means of the microscope. The sediment was removed from the water with the aid of long-handled rakes, whenever its presence became objectionable. Whenever the pool was emptied it was scrubbed thoroughly and washed out with clean water.

The air in the room is always kept at an even temperature of 72° F., and the room is sufficiently ventilated by means of vents in the roof. Windows on all four sides of the building allow an abundance of light to fall upon the water. This is in marked contrast with many swimming pools, which are located in basements.

Various Disinfection Experiments.

The first tests were made with copper sulphate, but had to be abandoned soon, on account of the hardness of the water. The carbonates of calcium and magnesium not only rendered the copper innocuous, but the cloudiness caused by the treatment made the latter objectionable. Furthermore, the presence of appreciable amounts of organic matter, which are usually to be found in swimming pools, lessen the value of the method. After employing copper sulphate in various dilutions, a rather extensive study was made of the action of chloride of lime on the water of the pool.

Chloride of Lime Treatment.

Special precaution was taken to have the conditions of the pool as nearly uniform as possible when the samples were taken for bacteriological examination. After the water had been stirred up thoroughly by bathers, samples were taken 10 or 12 ins. below the surface, on opposite sides of the pool, and were carried directly to the laboratory for examination.

Dilutions of 1 to 100 were used, and 0.5 c. c. of the diluted specimens were run from pipets into Petri dishes, and mixed with nutrient gelatin. Duplicate tests were made with each sample; and as there were always two samples, four series of plates were poured, and the average of the four colony enumerations recorded. It was found after frequent trials that the plates developed quite uniformly at a temperature of 18° C. in the course of six to seven days.

The chloride of lime was purchased in sealed bottles, and was guaranteed to contain 30% available chlorine. Some of the bottles were found to contain a little less of the chlorine than the guaranteed amount and in one case only 23%. The calculated amounts of chloride were carefully weighed, placed in cheesecloth bags and applied to the water by drawing the bags back and forth from one end of the pool to the other, 6 ins. below the surface and in lines about 4 ft. apart. Extreme precaution was observed to keep the disinfectant agent submerged during the entire time of treatment, in order to prevent any odor that might be objectionable to the bathers. No marked physical changes in the water could be noted; nor were any serious objections made to the condition of the atmosphere and of the water when the pool was treated secretly.

Results of Hypochlorite Treatment.

The accompanying table presents, in chronological order, the data of 13 tests made in the early part of 1911.

Test.	Date, 1911.	Time.	Hours after treatment.	Colonies per c.c.	% reduction
I.		Pool emptied and thoroughly cleaned.			
	Jan. 17	10.00 a. m.		45,300	Pool dosed 0.5 p. p. m.*
	Jan. 17	11.00 a. m.	1	1	99.98
	Jan. 17	4.00 p. m.	6	64	99.8
	Jan. 18	10.00 a. m.	24	890	98.14
	Jan. 19	10.00 a. m.	48	78,000	....
	Jan. 20	10.00 a. m.	72	259,200	....
	Jan. 21	10.00 a. m.	96	364,000	....
II.	Jan. 22	No sample. Sediment in pool raked out with long rakes and several feet of water replaced.			
	Jan. 23	10.00 a. m.		96,000	....
III.	Jan. 24	10.00 a. m.		58,200	....
	Jan. 24	10.30 a. m.	Pool dosed with 0.5 p.p.m.		
	Jan. 24	11.30 a. m.	1	390	99.33
	Jan. 25	10.30 a. m.	24	2,120	97.35
	Jan. 26	10.30 a. m.	48	34,200	....
	Jan. 27	10.30 a. m.	72	519,000	....
	Jan. 28	10.30 a. m.	96	769,000	....
IV.	Jan. 29	Pump going Saturday, Sunday and Monday nights. Pool not used until Monday (Jan. 29).			
	Jan. 30			35,000	....
V.	Jan. 31	10.30 a. m.		68,700	....
	Feb. 1	10.30 a. m.		71,000	....
	Feb. 2	10.30 a. m.		62,550	....
	Feb. 3	10.30 a. m.		56,760	....
	Feb. 4	10.30 a. m.		86,200	....
VI.	Feb. 5	Sunday. Pump going the entire day and night until samples were taken the next morning.			
	Feb. 6	morning		27,250	....
VII.		The two following samples were taken after the pool had not been used for several hours, and the figures show the effect of quiescence upon the bacterial counts.			
	Feb. 8	10.30 a. m.		14,150	....
	Feb. 9	10.30 a. m.		10,950	....
VIII.	Feb. 11	Pool emptied and thoroughly scrubbed with sand soap.			
	Feb. 12	Sunday. Pool filling.			
	Feb. 13	Pool filled to within 4 ft. of the top			
	Feb. 13	10.30 a. m.		45,800	....
	Feb. 14	10.30 a. m.		304,000	....
IX.	Feb. 14	8.00 p. m.	Pool treated with 0.3 p. p. m.		
	Feb. 15	10.30 a. m.	14.5	25	99.9
	Feb. 16	8.00 p. m.	Pool treated with 0.3 p. p. m.		
	Feb. 17	10.40 a. m.	14.5	100	99.6
X.	Feb. 22	Plates liquified in 3 days.			
	Feb. 23	10.30 a. m.		71,000	....
	Feb. 23	8.00 p. m.	Pool dozed with 0.5 p.p.m.		
	Feb. 24	10.30 a. m.	14.5	0	100
	Feb. 25	10.30 a. m.	38.5	6,650	....
XI.	Mar. 13	10.30 a. m.		46,150	....
	Mar. 13	8 p. m.	Pool treated with 0.3 p. p. m.		
	Mar. 14	10.30 a. m.	14.5	125	99.7
	Mar. 15	10.30 a. m.	38.5	30,400	....
	Mar. 15	8.00 p. m.	Pool again dosed with 0.3 p. p. m.		
	Mar. 16	10.30 a. m.	14.5	120,600	....
	Mar. 16	8.00 p. m.	Pool treated with 0.3 p. p. m. (see note).		
	Mar. 16	10.30 a. m.	14.5	12,000	99.5
	(In these tests the amount of available chlorine in the sample of hypochlorite powder was found by subsequent examination to be only 23%, instead of the "guaranteed" 30%. Hence the actual amount of such chlorine used in this experiment was considerably less than the above calculated amount, or only a little more than 0.2 parts per million.)				
XII.	Mar. 22	10.30 a. m.		496,600	....
	Mar. 22	8.00 p. m.	Pool dosed with 0.3 p.p.m.		
	Mar. 23	10.30 a. m.	14.5	600	99.8
	Mar. 23	8.00 p. m.	Pool dosed witm 0.3 p. p. m.		
	Mar. 24	10.30 a. m.	14.5	650	....
	Mar. 24	8.00 p. m.	Pool again treated with 0.3 p. p. m.		
	Mar. 25	10.30 a. m.	14.5	300	....
XIII.	Mar. 27	10.30 a. m.		604,800	....
	Mar. 27	8.00 p. m.	Pool treated with 0.4 p. p. m.		
	Mar. 28	10.30 a. m.	14.5	2,700	99.5
	Mar. 28	8.00 p. m.	Pool treated with 0.4 p. p. m.		
	Mar. 29	10.30 a. m.	14.5	0	100
	Mar. 29	8.00 p. m.	Pool treated with 0.4 p. p. m.		
	Mar. 30	10.30 a. m.	14.5	125	....
	Mar. 30	8.00 p. m.	Pool treated with 0.4 p. p. m.		
	Mar. 31	10.30 a. m.	14.5	450	....
	Mar. 31	8.00 p. m.	Pool again treated with 0.4 p. p. m.		
	Apr. 1	10.30 a. m.	14.5	350	....

*Parts per million of available chlorine.

Tests I., III. and X., with 0.5-part of available chlorine per million parts of water, gave reduction in the numbers of bacteria amounting to 99.98%, 99.33% and 100%, respectively. The bacterial counts remained small for at least 24 hours after the treatment. After the first 48 hours the numbers rapidly became greater, and in five or six days (Tests I. and III.) they far exceeded those which obtained before the application of the bleaching powder.

Tests IX., XI. and XII. show the effects of treatment with 0.3-part of available chlorine, the decrease in the total number of bacteria, as determined at the end of 14.5 hours, being 99.9%, 99.7% and 99.8%. By daily treatment with this amount of chlorine the number of bacteria was kept very small and quite uniform, except in Test XI., in which a poor quality of hypochlorite was used after the initial treatment, and the actual amount of chlorine applied fell far short of 0.3-part per million.

In Test XIII. 0.4-part of available chlorine per million was used, and the treatment was repeated daily for four days. The initial reduction in bacteria amounted to 99.5%. After the second dosing the samples were sterile, and from that time to the end of the experiment the numbers were almost negligible.

Test II. is given to show the effect of raking out the sediment, which was composed of hair, broken down epithelial tissue, etc. In IV. is seen the effect of dilution upon the number of

[1] Burrage, Proceedings of the Indiana Academy of Science, 1909. [See brief note on p. 740 of Eng. News for June 23, 1910.—Ed.]

[2] Bunker, American Journal of Public Hygiene, November, 1910, p. 810.

[3] This pool was described in Eng. News, Aug. 11, 1910.]

bacteria. In V. the bacterial counts are given for a period of five days during which the pool was not treated with disinfectant. Test VI. shows the effect of running the pump constantly for at least 24 hours. The two samples in Test VII. were taken on a morning when no swimmers were in the pool. The figures clearly show the effect of quiescence and the importance of taking samples under uniform conditions in the pool. In all the other experiments the pool was well stirred prior to the taking of the samples.

General Comments.

The use of hypochlorite of calcium in the disinfection of swimming pools results in a high degree of bacterial purification when used in such small amounts even as will furnish 0.3-part of available chlorine per million parts of water. Such treatment is in no way objectionable, if care is taken to prevent the odor of the bleaching powder from permeating the atmosphere of the room, and if the substance is well distributed through the water. In order to determine whether the treatment of the water affected the swimmers at all unfavorably, a large number of our experiments were carried on when no students and instructors were present, and when they had no intimation that the water was being treated. No complaints were made in such cases; on one or two occasions our attention was called to the unusual "sparkle" of the water.

Treatment with chloride of lime in the proportion of 0.3 to 0.5-part per million should prove to be a most effective means of preserving the purity of swimming pools. The treatment should be made daily, however, or at the most every 48 hours. If less often, the number of bacteria may become large, and even greatly exceed the number that was present before the chloride was used, as some of our experiments show. An obstacle that will often stand in the way when attempts are made to purify swimming pools by chemical means is the prejudice which so many students, and swimming instructors as well, have to introducing any foreign substance into the water, no matter how harmless that substance may be, or how badly the water may be in need of purification.

We take this occasion to thank Dr. Wm. G. Anderson, Director of the Yale University Gymnasium, for placing the Yale University swimming pool at our disposal, and for his deep interest and friendly cooperation in this work.

Progress in Grade-crossing Elimination on the Pennsylvania R. R. is marked by the approaching completion of the work in this line at Bristol, Pa. The new line will be put into service Nov. 26. The road is four-tracked at this place and ten grade crossings have been eliminated. The elimination work included the erection of bridges over seven streets—four bridges with solid reinforced-concrete floors supported by steel and three with reinforced-concrete slabs. In addition, a deck girder bridge with a solid reinforced-concrete floor was built over the Delaware & Raritan canal, and two streams were spanned by arches.

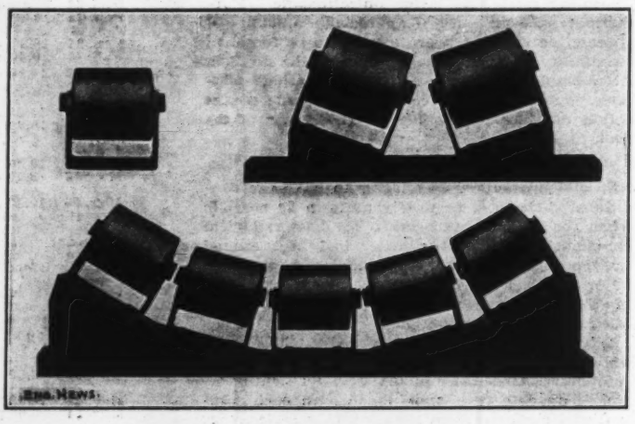
Besides the grade-crossing elimination, the improvement at Bristol includes the reduction of the maximum degree of curvature from 1° 40′ to 45′, and the total number of degrees of curvature is made less by 56°. The new line is a quarter-mile shorter than the one it supplants.

A new passenger station has been built on the south side of the tracks at Beaver Dam Road, Garden and Prospect Sts. It is on the street level and is connected with the track platforms by covered stairways. The total cost of the improvement work was $1,012,000.

A New Construction of Troughing Pulleys for Belt Conveyors.

The usual arrangement of pulleys to bend a conveyor belt into a trough shape involves the use of two sets of pulleys—one set mounted on a horizontal shaft under the middle of the belt and another set consisting of pulleys mounted at an angle on each side of the belt to turn up its edges. The width or number of rolls on each horizontal shaft is proportioned to the width of belt they are to carry. In case a given belt is to be replaced by a wider one, the horizontal pulleys must, in general, be discarded for wider ones.

A more flexible type of troughing and carrying pulley has just been put on the market by the Stephens-Adamson Manufacturing Co., of Aurora, Ill. As shown in the accompanying illustration, unit carrier pulleys a few inches in width are used and can be combined in any desired number or arrangement. Each unit consists of a cast-iron pulley fixed to a short shaft turning in ball-bearings supported by a simple steel-plate bracket. To form a complete carrier, a number of the units, depending on the belt width, are mounted end-to-end on a wooden block or steel channel. (Both steel and wooden supports are shown in the illustration.)



NEW TROUGHING PULLEY FOR BELT CONVEYORS.
(Combinations of pulley units can be arranged for any width of belt.)

Lubrication of the ball-bearings is effected by means of a dust-proof oil pocket at each bearing. It is claimed that the oil need be renewed not oftener than every six months under ordinary conditions. Another form of roller is made for lubrication by grease cups. The pulley revolves on a hollow shaft through which the grease is supplied. In assembling a complete carrier, special pipe connections are used between units so that grease cups are needed only at the outer ends of the outermost units.

Present State of Excavation in the Culebra Cut.*

On Nov. 1 there had been excavated from the Culebra Cut, which is nine miles long, 70,942,244 cu. yds. of rock and earth, and there yet remained 18,501,761 cu. yds. The average excavation per month during the 12 months just passed has been 1,372,000 cu. yds., and at this rate the work would be completed by Jan. 1, 1913. But this rate cannot be maintained, because sections of the Cut at either end are nearing completion, and the time is approaching when the number of shovels now at work (42) will have to be reduced because of lack of room in which to work and the output must therefore decrease.

At Bas Obispo and for a mile at that end of the Cut, the excavation is completed, except for a small amount of cleaning up and the taking out of inclines that must remain for the trains hauling spoil out of the trench on the north side of the summit. At the other end, near Pedro Miguel locks, there remain to be dug out about 800,000 cu. yds., in the canal and the anchorage basin, but this cannot be done un[illegible]e construction of the north approach and t[illegible]walls of the locks has advanced farther. Bet[illegible] that point and Cucaracha there remains ab[illegible]nough dig-ging to keep eight shovels bus[illegible] six months more.

By May 1, 1912, the excavation[illegible] Culebra Cut will be confined practically to the [illegible]e miles between Las Cascadas and Cucaracha[illegible] On that date there will remain to be excavated [illegible]t 11,000,000 cu. yds. It is expected that it w[illegible]e possible to work 30 steam shovels advanta[illegible]sly in this small section, an average of ten t[illegible]he mile. This number will be gradually diminish[illegible]as the excavation nears completion. There is every reason to believe that by July 1, 1913, the digging in Culebra Cut will be completed, except for such small amount of work as will be necessary after the steam shovels are taken out of the Cut. In this, no account is taken of the possibility of dredging of the last 15 ft. on the summit of the Cut, but it is assumed that all the work will be done by steam shovel.

It is possible that unexpected developments in the slides at Culebra and Cucaracha will add to the excavation yet to be done, but this need not delay the completion appreciably because if the material continues to move into the Canal after the water is let in it can be dredged more economically than it could be dug out by steam shovel. At Culebra, where the banks on both sides are sliding, the channel is already 1,580 ft. wide at top, and the earth is broken so far back on each side that the total width from break to break is 2,000 ft.

*From the "Canal Record," Nov. 8.

Notes from Engineering Schools.

LONDON ENGINEERING COLLEGE.—The New York alumni held a dinner Nov. 4 at the Engineers' Club, New York City, to celebrate the formation of the New York Alumni Association. The Association is the result of a movement begun by an American graduate of this college (full title, City and Guilds Engineering College of the Imperial College of Science and Technology, London). Among those present at the dinner was one who was a student at the college in the first year of its existence.

At the dinner, a constitution was drawn up and officers were elected as follows: Chairman, Hamilton Kilgour; Vice-Chairman, B. H. M. Hewett; Secretary, Wm. A. Del Mar. The Association starts with a membership of about 20.

A Surface Subsidence Over a Coal Mine at Scranton, Pa., Nov. 20, engulfed a two-family dwelling house on Ross Ave. The building dropped 60 ft., according to press reports, into the old workings of the Vonstorch mine of the Delaware & Hudson Co. The accident occurred at 5 a. m., and two of the nine inmates of the dwelling were carried down with it, but were subsequently rescued. The wreckage of the building was destroyed by fire.

Blame for the Wreck at Manchester, N. Y., on the Lehigh Valley R. R., Aug. 25, 1911, in which 29 persons were killed, is put upon the railroad company in a report submitted to the Interstate Commerce Commission, Nov. 20, by Mr. Herman W. Belknap, Chief Inspector of Safety Appliances. The report ascribes the accident to a defective rail and states that the company "was cognisant of the fact that there were defective rails in the service, of the character of the rail which caused the disaster, as evidenced by letters of instruction to subordinates, which are now in the hands of the Commission."

Press reports ascribe to an official of the Interstate Commerce Commission a statement that the rail which caused the wreck was first laid Oct. 31, 1910, but that it was taken up in April, 1911, and cut off 6 ft. shorter to make place for a new frog. It is claimed that the defectiveness of the rail should have been discovered when it was cut off.

This accident was noted in Engineering News, Aug. 31, 1911.

A Water Main Burst in Chicago, Nov. 15, at La Salle and South Water Sts. Damage estimated at $75,000 was done in flooded basements and in the new La Salle St. subway tunnel, now under construction. The electric power and telephone service in the vicinity was interrupted by the flooding of the conduits of the Illinois Tunnel Co. and Commonwealth Edison Co.

A Compressed Air Tank Explosion at the power house of Swift & Co., in Chicago, Ill., Nov. 18, killed four men and injured one other. Press reports state that the tank exploded soon after it had been installed and that workmen were preparing to connect it with the compressed air line when the accident occurred, but no explanation is given as to the nature of the explosion.

A Boiler Exploded Nov. 16, near Freebridge, N. Y. Four men asleep in the boiler room were killed by escaping steam. The men killed were employed by Scott Bros., Contractors on the Barge Canal. Reports state that the boiler had been inspected Oct. 31 by the State Inspector and pronounced satisfactory.

A Coal Mine Explosion Nov. 18, in the Bottom Creek mine of the Bottom Creek Coal & Coke Co., at Vivian, W. Va., killed 18 men and injured four others. There were more than 150 men in the mine at the time of the explosion. Among the men killed, according to reports, were four engineers who were making the semi-annual survey of the mine.

A Rear Collision on the Northern Pacific Ry., Nov. 16, three miles west of Pipestone, Mont., between a passenger train and a work train, caused the death of six men who were riding in the work train's caboose.

A Derailment at a Cross-Over at Monmouth Junction, on the Pennsylvania R. R., Nov. 17, caused the death of the engineer and fireman of the Philadelphia and New York express train, which left Philadelphia at 4 p. m. The locomotive was overturned and three coaches were derailed. None of the 200 passengers, however, was seriously injured. The accident was quite similar to that on the New York, New Haven & Hartford Ry. at Bridgeport, Conn., described in Engineering News, July 20, 1911. The derailment occurred at a speed estimated at 50 mi. per hr., and the accident is ascribed to the failure of the engineer to slow down for the cross-over, although he was informed that his train was to take the cross-over at this point. The small loss of life in the present accident is ascribed to the fact that the coaches were all of steel.

A Rainfall of 4.67 ins. in 24 hours was recorded by the Weather Bureau station at Hartford, Conn., on Oct. 18-19. The total precipitation at the station for the month of October was 7.3 ins.

An Earthquake in Germany and Switzerland did considerable damage to buildings Nov. 16. The shock was most severe in Switzerland, according to reports. Buildings were partly wrecked in Berne and Zurich and street cars were derailed in Geneva.

The Coroner's Jury Investigating the Austin Dam failure on Nov. 21 brought in a verdict charging that the failure was "due to gross negligence on the part of George C. Bayless, President, and Fred N. Hamlin, Superintendent, of the Bayless Pulp & Paper Co." These men have been brought before Justice Thompson, at Coudersport, Pa., for a preliminary hearing on the charge of manslaughter.

Public Hearings on Conservation Problems in New York State have been held for some weeks past by the State Conservation Commission. Particular attention is being given to water-supply.

Licenses for Dam Construction are advocated by a committee appointed by the Engineers' Club of Philadelphia soon after the failure of the dam at Austin, Pa. The recommendations of the committee, which were unanimously adopted by the club, were as follows:

We recommend that no such structure shall be built without a license from the State to the owner, the license to set forth the names of the engineering staff to be in charge of the design and construction. In granting this license the State reserves the right to inspect the construction of the work at any time during progress to determine if the provisions of the license are being carried out; but, by the granting of such license and inspection the State does not assume any liability or guarantee the safety of the structure, and any failure on the part of the licensee to meet these provisions shall be a criminal offense against the Commonwealth, and punishable by law accordingly.

The Main Canal of the Yuma Irrigation Project, Arizona-California, is about to be put under construction by the contractors. The canal will be some nine miles in length, extending from a point three miles north of Yuma to a junction with the existing canal a little over a mile below the Laguna Dam. The work involves about 1,300,000 cu. yds. of excavation.

A Dinner for the New York, Westchester & Boston Ry.'s engineering department will be given by the members of that department at Healy's, Columbus Ave. and 66th St., New York City, on Saturday evening, Dec. 2, at 8 p. m. Former members of the department who desire to be present should communicate with Mr. P. H. McCormack, 105 Madison St., Mount Vernon, N. Y.

The Canal Terminal Measure in New York State, which was before the people in the election of Nov. 7, is still in doubt. Returns from about one-third of the up-state counties show a vote against the propositions of some 30,000, while somewhat less than half of the assembly districts in the New York City counties show a favorable vote of 14,000. Final returns are not expected for some time. The two propositions before the people were, first, an authorization of a bond issue of $19,800,000 to pay for the cost of the necessary terminal works and second, an amendment to the State constitution guaranteeing the protection of such terminal works from sale or lease to private companies.

Irrigation Statistics of Texas.—The irrigated area of Texas, according to a recent Census bulletin, increased enormously in the 10 years just past; the total irrigated area in 1899 was 49,652 acres, and in 1909, 450,971 acres, an increase of 808.3%. The area included in projects either completed or under construction in 1910 was 1,252,935 acres, an excess of 801,964 acres over that irrigated in 1909, showing that the area irrigated can be almost tripled without undertaking new enterprises. The total length of all ditches in 1909 was 2,685 miles, of which 1,473 miles were in main canals and 1,212 miles in laterals; an increase of 227.3% in 10 years. The total number of all pumping plants was 2,374, using in all 66,130 HP., which irrigated 351,761 acres, or 78% of the total in 1909. Flowing wells supplied water for 3,731 acres; streams, 374,287 acres, or 83%; lakes, 458 acres, or 0.1%; wells, 56,409 acres, or 12.5%; springs, 13,068 acres, or 2.9%, and reservoirs, 6,748 acres, or 1.5%. Of all the area under irrigation in 1909 63.6% of the total was in the rice belt. The total cost of irrigation systems in 1910 was $13,406,831 against $1,027,608 in 1899, an increase of 1,204.7%. The average cost per acre in 1910 was $19.33, against $20.70 in 1899. The average cost of operation and maintenance per acre in 1909 was $3.25. No lands in 1909 were irrigated by the U. S. Reclamation Service, the U. S. Indian Service, under the Carey Act, or district irrigation enterprises.

Floods in Washington, affecting a number of rivers in the western part of that state, were caused by the warm "chinook" winds of Nov. 16-19, which both brought heavy rains and melted the six feet of early snow in the Cascade Mountains. On Nov. 19, according to reports, the dam of the Municipal Electric Plant of Seattle was carried away and the city's water supply was also interrupted. A number of bridges were carried away and railways were blocked by landslides.

Reports state that on the Skagit River the flood cut a channel through a neck of land 80 rods across at Sterling Bend, above Mount Vernon, Wash. The new channel is described as being 300 ft. wide and 20 ft. deep. It shortens the distance from Mount Vernon to Sedro-Wooley by 3½ miles giving a shorter and safer steamboat channel. Reports state that this action of the flood obviates the need of river-improvement work contemplated for some time by the U. S. Government.

Personals.

Mr. E. Hardgrove, Superintendent of Sewers of the Borough of Queens, New York City, has resigned.

Mr. Emanuel Brandon, Superintendent of Highways of the Borough of Queens, New York City, has resigned.

Mr. R. W. Leonard, M. Can. Soc. C. E., of St. Catharines, Ont., has been appointed Chairman of the National Transcontinental Railway Commission of Canada, succeeding Hon. S. N. Parent.

Mr. D. J. Mullen, formerly Master Mechanic of the Cleveland, Cincinnati, Chicago & St. Louis R. R. at Mt. Carmel, Ill., has been promoted to Master Mechanic of the St. Louis and Cairo divisions at Mattoon, Ill., of the same railway.

Mr. H. M. Church has been appointed Engineer of Maintenance-of-Way of the Wheeling System of the Baltimore & Ohio R. R., at Wheeling, W. Va., succeeding Mr. J. A. Spielman, promoted.

Mr. H. C. Manchester, Superintendent of Transportation of the Maine Central R. R., at Portland, Me., has been appointed Superintendent of Motive Power and Equipment of the Delaware, Lackawanna & Western R. R., to succeed Mr. T. S. Lloyd, whose resignation was announced in our issue of Nov. 9.

James A. McCrea, formerly General Superintendent, has been appointed General Manager of the Long Island R. R., the duties of which position have hitherto been performed by Mr. Ralph Peters, President of the company. Mr. McCrea is a son of Mr. James McCrea, President of the Pennsylvania R. R., and is graduate of Sheffield Scientific School, Yale University, class of 1895. From 1897 to 1905 he went through the various engineering grades of the Pennsylvania R. R. from rodman to Division Engineer of Maintenance-of-Way. For five years, 1901 to 1906, he was Superintendent of the Cincinnati Division of the Pennsylvania Lines; since that time he has been General Superintendent of the Long Island R. R. a subsidiary of the Pennsylvania R. R.

Mr. Henry W. Thornton, Assistant General Superintendent of the Long Island R. R., has been promoted to General Superintendent of the same, succeeding Mr. James A. McCrea, promoted. Mr. Thornton is a graduate of the University of Pennsylvania, class of 1894, and made his way up from draftsman in the engineering department of the Pennsylvania R. R. In 1899-1901 he was Division Engineer of Maintenance-of-Way, and afterward Superintendent of the Erie & Ashtabula division of the Pennsylvania R. R. He was made Assistant General Superintendent of the Long Island R. R. about a year ago.

Obituary.

Caryl Davis Haskins, M. Am. Inst. E. E., Manager of the Lighting Department of the General Electric Co., of Schenectady, N. Y., died from pneumonia on Nov. 18, at Salt Lake City, Utah, after but two days' illness. A biographical sketch of Mr. Haskins will appear in our issue of next week.

Hugh Redmond, a United States Government engineer employed in the Philippine Islands, died at Nalolos, Bulacan Province, P. I., on Oct. 24, from injuries received in a motorcycle accident. He was a graduate of Cornell University, class of 1903, and was employed for some time in irrigation work in Arizona. A widow and three children survive him.

George Whiting Hebard, Vice-President of the Westinghouse Electric & Mfg. Co., of Pittsburgh, Pa., died at his home in New York City on Nov. 17. He was born in Barre Center, Olean Co., New York, in 1845. He came to New York City in 1869 and became extensively interested in manufacturing and electric lighting companies. He was a director of several large manufacturing companies, including the Union Metallic Cartridge Co., of Bridgeport, Conn., the Remington Arms Co., of New Haven, Conn., and others. He leaves a widow and two sons.

Dr. Walter Wyman, Surgeon General of the United States Public Health and Marine Hospital Service, died in Washington, D. C., on Nov. 21. He was born in St. Louis, Mo., in 1848. He was graduated from the City University of St. Louis, Amherst College, Mass., and the St. Louis Medical College. He entered the Marine Hospital Service in 1876 and had been Surgeon General since 1902. He was the author of numerous pamphlets and reports on matters connected with public health work.

Thomas Hall, an inventor and patent attorney of Brooklyn, N. Y., died on Nov. 19. Mr. Hall was chiefly famous as an early inventor of the typewriter. He was born in Philadelphia, Pa., in 1834, and educated at the University of Lewisburg, Pa. He devised a mechanism for printing by touching keys, and exhibited at the Paris Exposition of 1867 one of the first typewriters. He later studied in Europe, and in 1881 placed on the market in this country the Hall typewriter. He was also the inventor of sewing machine mechanisms, drill grinders and other machinist's tools.

Edgar W. Mix, M. Am. Inst. E. E., formerly an engineer with the General Electric Co., at Schenectady, N. Y., and recently a noted electrical engineer and aeronaut in France, committed suicide on Nov. 12, by shooting, while on a steamer crossing the English Channel. At the time of his death he was Manager of the European division of the General Motors and Export Co., of Detroit, Mich. He was the winner of the international balloon race at Zurich, Switzerland, in 1909, and had been promi-

nent in the Aero Club of France and the Aero Club of America for a number of years.

Frederic Cope Whitehouse, famous for his irrigation schemes on the River Nile in Egypt, died in New York City on Nov. 16. He was born at Rochester, N. Y., in 1842, and educated at Columbia University, where he graduated in 1861 and received a Master's degree in 1863. Later he studied abroad in France, Germany and Italy, returning to this country in 1871, when he was admitted to the bar in New York State. In 1882, he discovered the depression in the Egyptian desert now known as the Wadi Raiyan, and was long interested in using it as a reservoir basin for irrigation purposes. For his efforts in the development of Egypt he was made a Commander of Osmanieh and Grand Officer Medjidieh by the Khedive. He was a member of many learned societies in this country and abroad, and was a writer on scientific subjects.

Engineering Societies.

COMING MEETINGS.

NEW JERSEY SANITARY ASSOCIATION.
Nov. 24-25. Annual meeting at Lakewood, N. J. Secy., J. A. Exton, 75 Beech St., Arlington, N. J.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 4. Annual meeting at New York City. Secy., William H. Ross, 154 Nassau St., New York City.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Dec. 4-9. Annual meeting at Havana, Cuba. Secy., Wm C. Woodward, Washington, D. C.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 5-8. Annual convention at New York City. Secy., Calvin W. Rice, 29 West 39th St., New York City.

NATIONAL IRRIGATION CONGRESS.
Dec. 5-9. Annual session at Chicago, Ill. Secy., Arthur Hooker, 214 Hotel La Salle, Chicago, Ill.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 11-13. Annual meeting at New York City. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Pa.

AMERICAN INSTITUTE OF ARCHITECTS.
Dec. 12-14. Annual convention at Washington, D. C. Secy., Glenn Brown, the Octagon, Washington, D. C.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 20-22. Annual meeting at Washington, D. C. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 27-29. Annual meeting at St. Paul, Minn. Secy., J. B. Davidson, Ames, Iowa.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 27-Jan. 3. Annual meeting at Washington, D. C. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.
Jan. 6. Annual meeting at Seattle, Wash. Secy., Joseph Jacobs, 803 Central Bldg., Seattle, Wash.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.
Jan. 9. Annual meeting at New York City. Secy., J. R. Wemlinger, 13 Park Row, New York City.

MICHIGAN ENGINEERING SOCIETY.
Jan. 9-11. Annual meeting at Lansing, Mich. Secy., Alba L. Holmes, 574 Wealthy Ave., Grand Rapids, Mich.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 16. Annual meeting at Pittsburgh, Pa. Secy., Elmer K. Hiles, 2511 Oliver Bldg., Pittsburgh, Pa.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17-18. Annual meeting at New York City. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

SOCIETY OF AUTOMOBILE ENGINEERS.
Jan. 18-20. Annual meeting at New York City. Secy., Coker F. Clarkson, 1451 Broadway, New York City.

Washington Society of Engineers.

The annual dinner was held Nov. 21 at Rauscher's in Washington, D. C. The annual meeting will be held Dec. 19 at the Cosmos Club Hall.

American Automobile Association.

The "Federal Aid" good-roads convention of this Association will be held in Washington, D. C., Jan. 16-17.

Municipal Engineers of the City of New York.

At the regular meeting of Nov. 22 Mr. Calvin Tomkins, Commissioner of Docks and Ferries, New York City, read a paper entitled "The Port of New York."

Society of Automobile Engineers.

Papers to be presented at the annual meeting in New York City, Jan. 18-20, are announced as follows: "Compound Gas Engines and Their Efficiency," Eugene P. Batzell; "Present Status of Automobile Lighting, Gas and Electric," J. W. Esterline and A. F. Berdon; "Short-and-Long-Stroke Motors," John Wilkinson; "Definitions in Connection with Physical Properties of Steel," Henry Hess; "Mechanical Points in Connection with the Construction of Solid Motor Tires," Charles B. Whittelsey; "Silent Chain Transmission," Lester S. Ricker; "Automatic Spark Advance," Lon R. Smith; "Balance of Motors," Ernest R. Fried; "Effect of Use of Silicon in Steel," Marcus T. Lothrop; "Trend of European Automobile Design," Charles Y. Knight; "The Necessity of Standard Gages for Commercial Vehicles as Viewed from Railway and Other Engineering Practice," Hermann F. Cuntz; "Multiple Disc Clutches," Joseph A. Anglada.

Committee reports will be presented by the following brances of the Standards Committee: Ball and Roller Bearings, David Fergusson, Chairman; Broaches, C. E. Davis, Chairman; Carbureters, G. G. Behn, Chairman; Frame Sections, J. G. Perrin, Chairman; Iron and Steel, Henry Souther, Chairman; Miscellaneous, A. L. Riker, Chairman; Nomenclature, H. E. Coffin, Chairman; Seamless Steel Tubes, H. W. Alden, Chairman; Springs, A. C. Bergmann, Chairman; Truck Standards Division, W. P. Kennedy, Chairman.

The meeting will be held during the week of the commercial-vehicle division of the Automobile Show at Madison Square Garden. The society's sessions will be held in the Madison Square Garden assembly hall.

Western Railway Club.

At the regular meeting in the Auditorium Hotel, Chicago, Nov. 21, Mr. Michael Schwarz, Manager of the Alcohol Utilities Co., presented a paper on the "Use of Denatured Alcohol in Railway Service." Mr. Schwarz's paper discussed first the extent of the use of alcohol for lighting, heating and power purposes in the United States previous to the establishment of the heavy tax on spirits. He mentioned also its extensive use in Germany at the present time. For lighting purposes, the field for denatured alcohol was that now occupied to a large extent by the kerosene lamp. Railway waiting rooms in country towns and small cities were in many cases lighted, very unsatisfactorily, by kerosene lamps, which might be replaced to advantage by lamps burning denatured alcohol.

The report of a test made by the Electrical Testing Laboratories of New York City was quoted, in which alcohol and kerosene lamps were compared as follows:

	1 gal. will last	Av. c.p.	C.p. hrs.
Alcohol	38 hrs. 30 min.	45.2	1,740
Kerosene	32 hrs. 42 min.	14.8	484

About 3½ times as many candle-power hours were obtained from a gallon of alcohol as from one of kerosene. The test showed that with alcohol at 45 cents per gal. a single mantle burner would furnish 45 candle-power at a cost of 1.2 cents per hour.

Alcohol stoves for cooking, Mr. Schwarz stated, were being used with success by the Pullman Co. in buffet cars, where they had in numerous cases replaced gas stoves.

A denatured-alcohol heater for refrigerator cars used for carrying perishable freight in winter had been developed which would burn for ten days without attention. The products of combustion were kept in the car, instead of passing out a stack, thus increasing the heating effect.

American Institute of Chemical Engineers.

The program for the fourth annual meeting to be held in Washington, D. C., Dec. 20-22, includes the following papers: "Advances in Testing Explosives," Clarence Hall, Pittsburgh, Pa.; "Distribution of Power in Portland Cement Manufacturing," Richard K. Meade; "Manufacture of C. P. Acids," J. T. Baker; "Combustion of Pulverized Coal," L. S. Hughes; "Manufacture of Gelatin," Ludwig Thiele; "The Natural Bituminous Rocks of the United States," S. F. Peckham. These papers will be presented at the Wednesday morning session at the New Willard Hotel. A meeting will be held Wednesday evening, at which Mr. F. W. Frerichs, the retiring president, will give an address entitled "Some Problems in Chemical Engineering Practice. A—Manufacture of Chloroform from Alcohol. B—Construction of Laboratory Apparatus. C—Manufacture and Testing of Shipping Cylinders for Liquid Ammonia Gas." A paper on the "Manufacture and Testing of Carbonic Acid Cylinders," by John C. Minor, Jr., will also be presented at this meeting.

At the Friday morning session there will be a symposium of papers on the United States Patent System as follows: "The United States Patent Office," E. B. Moore, Patent Commissioner, U. S. Patent Office; "Patent Office Procedure: Practice of Patent Law Up to the Issue of the Patent," Edward T. Fenwick, of Mason, Fenwick & Lawrence; "Protection of Inventions by Patents; Existing Defects and Remedies Therefor," Walter D. Edmonds, of Edmonds & Peck; "The United States Patent System," R. N. Kenyon, of Kenyon & Kenyon. On Friday evening Mr. F. G. Wheeler will present a paper entitled "The Adaptation of the Centrifugal Pump to Chemical Service." Mr. J. C. Olsen will describe "A Course in Chemical Engineering Education," prepared in accordance with the vote of the Institute on the list of questions of December, 1910.

Wednesday afternoon will be devoted to a visit to the Bureau of Standards. On Thursday there will be an excursion to the United States Proving Grounds at Indian Head, Md. President Taft will receive the members of the Institute in the east room of the White House on Friday afternoon. Following the reception, the members will visit the United States Patent Office. Excursions will be made on Saturday, Dec. 23, to a steel plant at Sparrows Point, Baltimore, and to the cement plant of the Tidewater Portland Cement Co.

American Railway Bridge and Building Association.

The 21st annual convention was held at the Planters' Hotel, St. Louis, Mo., Oct. 17-19. The convention was called to order Tuesday morning by President Rettinghouse and was opened with prayer, in accordance with this association's regular custom. Mr. Rettinghouse in his opening address stated that the membership had increased from 193 in 1900 to 490 in 1911. The secretary's report showed that 90 members had been added during the past year, and the treasurer's report showed a balance on hand of $682.

The report of the Committee on "Fireproofing Trestle Bridges" was presented by Mr. Lee Jutton, Chairman. Among the different methods of fireproofing mentioned in the report and the discussion which followed were the covering of caps and stringers with sheet iron and the use of so-called fireproof paint. Sheet iron covering was objected to on the ground that it rendered inspection of the timbers difficult, and that the sheet iron was quickly rusted away by drippings from refrigerator cars. At the afternoon session the report of the Committee on "Derricks for Handling Material in Supply Yards" was presented. Very little data had been secured on derricks for yards use only, although a number of roads had sent information regarding derricks used both in yards and on the road. The report of the Committee on "Best Methods of Numbering Bridges" was read by Mr. Jutton in the absence of the Chairman, Mr. Stern. The discussion on this report was concerned with the relative merits of the consecutive and the mileage systems of numbering. The report on "Arrangement of Depot Platforms," read by Mr. C. H. Fake, was a continuation of the last year's report of the same committee.

On Tuesday evening a short session was held, at which the report of the Committee on "Roofs and Roof Coverings" was presented. In the discussion Mr. Morris Coburn, Chairman of the Roofing Committee of the American Railway Engineering Association, gave it as his opinion that coal-tar roofing was cheaper and better in the long run than asphalt roofing. His position was contested by the representatives of various manufacturers of asphalt roofing.

The report of the Committee on "Brick Veneer for Station Buildings," which was read at the Wednesday morning session, stated that brick veneer was not considered of any great advantage, for the reason that it made the cost very little less than that of a brick building. The report on "Concrete Tank Construction" was also read at this session. At the afternoon session a brief report was presented by the Committee on "Pumping Engines." The committee will be continued through the coming year and was authorized to make such tests as might be found necessary. The next report was that of the Committee on "Embankment Protection," and the discussion of this report concluded the meeting, as no report had been prepared by the Committee on "Bridge and Building Records."

Officers for the coming year were elected as follows: President, F. E. Schall, So. Bethlehem, Pa.; Vice-Presidents, A. E. Killam, Moncton, N. B.; J. N. Penwell, Tipton, Ind.; L. D. Hadwen, Chicago, Ill., and T. J. Fullem, Chicago, Ill.; Secretary C. A. Lichty, Chicago & Northwestern Ry., Chicago, Ill.; Treasurer, J. P. Canty, Boston, Mass.

The next convention will be held at Baltimore, Md., Oct. 15-17, 1912.

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